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VOL. XIV. NEW YORK, JULY 20, 1889. No. 3.

A Cable Consolidation. IT would appear that the consolidation between the Commercial and French cable companies that has been on the *tapis* so long has at last been effected, and that Mr. George G. Ward is himself making the changes in the service necessary under the transfer. This absorption renders the Commercial Company much stronger, and should enable it to give a service even more efficient than it has given in the past.

The Westinghouse Consolidation. IT will be seen from a news note elsewhere that the projected Westinghouse electrical consolidation has been carried through, and that the new company represents an imposing aggregation of interests, patents and capital. Although the combination is doing business, it is stated, at the rate of $12,000 per day, the capital stock will, it is understood, stand at $5,000,000, a figure none too large, if even large enough, for such an enormous industry.

Wiring and Inspection. THE report made by our New England correspondent of the working of the New England Electric Exchange, and of the good results that have attended its operations, is encouraging to all who believe that the standard of electrical installations can and should be raised. The Exchange has begun well, and has set an example that might well be imitated elsewhere. It will be seen that the Exchange has strengthened itself by incorporating under the laws of Massachusetts.

Electrical Execution. A VERY interesting and important investigaon was that begun last week, as to whether electrical execution is a cruel form of punishment. Our report of the proceedings shows very clearly that such an inquiry would be far more satisfactory if there were more definite information on the subject. There is, it would seem, no Vivisection Society to interfere on behalf of the criminal to save him from furnishing the data by his dying agonies.

The Paris Meter Competition. THE first meeting has been held of the committee of experts appointed by the city of Paris to render a decision on the merit of the electric meters submitted in its prize competition. There are 27 entries, and 18 of the competitors have sent in operative apparatus, the others limiting themselves to descriptions and drawings. We are glad to learn that America is well represented, and we trust that the Lutetian laurels in this interesting contest may be brought across the Atlantic.

Long Distance Religion. THE instances of the successful transmission of religious services by the telephone are not few, but they have never gone much beyond an occasional demonstration. It is now reported, however, that the South of England Telephone Company has already sixteen wires connected with a church in one of the towns it serves, and that several more houses far and near are being "joined up." Probably the practice will gain in frequency with time, but in spite of many advantages we hardly expect to see the long distance telephone office become the Church of the Future. The insuperable objection to the parsonic mind will be the impossibility, under such conditions, of making the "usual collection."

Postal and Telegraph Figures. ONE of the attractions of the Paris Exposition is a great model of the earth, accompanied by tables of data. From these tables it appears that the United States sends 90 telegrams per annum per 100 inhabitants, or just as many as England, 10 more than France or Holland and 50 more than Germany. Turning to postal figures, it appears that England has 40 letters per annum per inhabitant, Switzerland 30 and Belgium 25, while the United States has only 20. According to some persons, the control of the telegraphs in America by private capital has placed us at a disadvantage as compared with nations basking in the glorious privileges of government telegraphs, yet these statistics tell quite a different story.

A Government Telegraph Rate. IT is not very clear why the Postmaster General should insist on cutting down the rate it is to pay for telegraph service from 1 cent to 1 mill per word. The reduction is so absurd on its face that people naturally wonder as to the aim or intention that led to it. Mr. Wanamaker ought to know, and probably does know, that telegrams cannot be "marked down" in the same way as tapestries or tinware; and yet he acts as though the old rate was not only too high, but ten times more than it should have been. Every one familiar with the telegraphic business is aware that 1 cent per word is a reasonable charge, but the government, through the Postmaster-General, has now informed the public that it believes that telegraphing should be done at 1 mill. What is the meaning of this policy? Does the government propose to reduce the surplus by buying out Mr. Gould?

Storage Battery Distribution. THE economy to be attained by the continuous operation of machinery at its maximum capacity finds no greater confirmation than in electric lighting. Indeed, the methods of overcoming the bad effect of irregularity of service have been the principal study of the electric light engineer for some time past, and have been among the principal topics of discussion before the National Electric Light Association. The introduction of the electric motor has succeeded in practically solving this difficulty for incandescent circuit distribution, but the question of utilizing arc light stations to their fullest capacity is still considered by many to await successful solution. It was early suggested to employ such stations for the charging of storage batteries during the day-time to feed incandescent lamps at night, and this has been done in several instances. A well-worked-out system of this kind is that described in another column and now in operation in Brooklyn. The manner in which a single wire is made to serve both as the arc light conductor and the battery charging conductor will attract attention. Heretofore these circuits, though operated at different times from the same machine, have consisted of separate wires. By the reversal of the current in connection with a polarized switch, one wire has been made by Mr. Knowles to serve in a double capacity, an improvement which ought to do much towards the extension of this system of distribution.

Popularity of Electric Railways. A FAIR notion of the popular interest in electric railroads may be formed from the manner in which the newspapers have opened their columns to eulogistic descriptions of these novelties in the field of urban passenger traffic. Last Saturday, for example, the *Commercial Advertiser*, of this city, contained an excellent article from Ernest Ingersoll on the successful Sprague road put in by the late Maurice B. Flynn and associates at Richmond, Va., and the following day the New York *Press* came out with a long illustrated article entitled "Aow Electric Cars Are Run." The article contains reference to Mr. Leo Daft's work on the Ninth Avenue elevated road, and the remainder of it is mainly devoted to the ordinary overhead system, as practised in Richmond, Cleveland, Omaha, Cincinnati, Boston and other cities. That it is written in a generous and appreciative spirit may be judged from the following passage: "To mention the advantage of electric over horse power in the propulsion of street cars would be to take up every detail of the working and in nearly every instance point out the superiority of the electric system." Mr. Ingersoll in his article on the Richmond road, which he has investigated, states that it is carrying 200,000 passengers a month; that it is operated more cheaply than a horse road; that it makes greater speed than the ordinary street road, and that its success has been the basis of a remarkably healthy "boom" in city and suburban real estate. One need not wonder that nearly every city in the country is going in for electric roads.

The Edison Three-Wire System. WE devote considerable space in this issue to an article by Mr. W. J. Jenks, based on a lecture delivered by him a few weeks ago before the New York Electrical Society. The article presents in condensed form the whole history and present practice of the three-wire system, and as such satisfies the numerous questions which are frequently asked regarding this system, but which have thus far been generally left unanswered. The history of the three-wire system is an interesting one and begins with the recognition shortly after the commercial introduction of the incandescent light of the necessity of reducing the cost of conductors, but at the same time leaving the system unchanged in so far as the complete independence of each lamp was concerned. Exactly how the weight of conductor is reduced by means of the system, and to what extent, is very clearly shown by Mr. Jenks, and though the doubt regarding this point still occasionally crops up, theory agrees so well with practice that we must consider the disagreements hereto fore existing as due more to differences in the points of view taken by the disputants than to matters of fact. The actions which take place and the direction and strength of the currents in the various parts of the system under different conditions are very beautifully demonstrated by means of the water analogues made use of by Mr. Jenks, which cannot fail to place vividly before the mind of the student the essential actions involved in the three-wire system, as well as the manner in which it differs from other methods of distribution. Referring to the criticism which has been made, that in actual work the system is not in harmony with the law enunciated by Sir Wm. Thomson with respect to the most economical size of conductors, it is pointed out that though the law is undoubtedly true, it can only be applied absolutely to circuits carrying a constant load which can be predetermined with tolerable accuracy. Where the loads are variable, as in commercial incandescent lighting, during different hours of the day, the law cannot be followed strictly if other conditions dictated by successful practice are to be obeyed; another instance of theory, though true, modified by practice. An important part of Mr. Jenks' article is that treating of the distribution, and, more particularly, the equalization, of pressure throughout the system. This, so important in the two-wire system, is evidently an absolute necessity in the three-wire, if economy and regularity in operation is to be achieved. The methods adopted, of which the "feeder" may be said to be the prime factor, and involving the pressure indicator and feeder equalizer, are well described, and the description will be read with interest. Electric lighting in its details was of necessity obliged to follow as closely as possible the lines and practices laid down in the distribution of gas, in order to secure a more ready introduction, but, as Mr. Jenks points out, gas engineers have also profited materially by the work of the electrician. Thus the "feeder" methed of obtaining uniform pressure is now being followed in the distribution of gas, where heavy pipes are carried for miles in order to get at the centre of distribution. The numerous other details of the three-wire practice given by Mr. Jenks, which cannot be referred to here, present an excellent résumé of the system as it exists in successful operation to-day.

NEW BOOKS.

A Dictionary of Electrical Words, Terms and Phrases. By Prof. E. J. Houston. New York, The W. J. Johnston Company, Ltd. 1889. 397 Illustrations. 650 Pages. Price, $2.50.

Preliminary Notice.

It will be remembered that Ruskin, in one of his lectures on storm clouds, found fault with phraseology used by Professor Tyndall, and complained that in attempting a discussion of the colors of diffraction or interference he was brought to a dead stop by the frightful inaccuracy of the terms employed by scientific people. Perhaps the language of Tyndall was not so much out of the way after all, but it has seemed that the man of ordinary culture, unfamiliar with electricity, must echo this charge when he notes how often, in order to get a forcible expression for some hitherto unidentified phenomenon or for some novel invention, the electrician wrests an old word from its wonted meaning or melts it down to be recast in a new coinage. In fact the terminology of electricity is still so modern that little of it has received the seal of approval by inclusion in even the latest dictionaries; yet by the very necessities of the case the electrician and the electrical engineer are driven to enlarge their vocabulary, and it may be doubted whether expansion of the language is proceeding in any department more rapidly than it is in electro-technics. The multiplicity of electrical developments in every direction requires definitions, distinctions and differentiations that were but recently superfluous, and the result is that while the expert himself can hardly keep abreast of all the discovery and utilization that is going on, the hundreds of words that he adopts or creates pass quickly into the daily newspapers and latest books to bewilder and perplex the public in a manner that probably has never been equalled.

It will be seen, then, that an authoritative electrical dictionary is a want of the times. Such a work is indispensible to the journalist for handy reference. When newspapers in cities can talk of "ohms of electric force" and of "magnetism souring on the stomach," there is evidently much to be accomplished by such a work among those by whom the instruction of the public is now so largely performed. Professional men generally need a work of this kind, since electrical questions arise daily in law, medicine, engineering and other branches; while the manufacturer and merchant may be enabled by it to appreciate the meaning of terms employed in an art that bids fair to affect all the great industries. To the electrician, whether student or practitioner, the book has become extremely necessary as a labor saver and as a guide or a tool. So general, indeed, has the demand for it grown to be that no doubt can any longer be entertained as to the welcome that awaits the appearance of a worthy production of this nature.

In examining the "Dictionary of Electrical Words, Terms and Phrases" that is now laid before the public, one comes to the conclusion that its estimable author, Prof. E. J. Houston, has had no easy or enviable occupation. There are various ways of approaching a task of this kind. The great Englishman who characterized himself in his own noble dictionary as a harmless drudge busied in tracing the original and detailing the significance of words, cannot be said to have grappled with the undertaking very zealously, and he describes his work as being done by fortuitous excursions into books, gleaning as industry should find or chance should direct. A more ardent spirit is that of Littré, who toiled at his magnificent dictionary of the French language for thirty-three years, and whose proof-sheets, subjected at one time to the tender mercies of the German invader, at another were read amid the fierce clamors of the Chamber of Deputies. We must look to Littré as well for the method as the spirit in which work of this character should be carried out, and it is pleasing to recognize his influence in Dr. Murray's dictionary published in England and in Dr. Whitney's dictionary now being issued by the *Century*. To this school of lexicographers, Prof. Houston belongs, and his dictionary must be regarded as a brilliant exemplification of ability and energy well applied in a philological and scientific department that never before received adequate treatment. His work will, it is believed, be to the terminology of electricity what Johnson's dictionary has been to the English tongue; its many merits entitling it to immediate recognition and to a permanent place in the standard literature of the science.

Some idea of the scope of the work and of the immense amount of labor involved in it, may be formed when it is stated that the dictionary includes close upon 2,500 distinct words, terms or phrases. Each of the great classes or divisions of electrical investigation or utilization comes under careful and exhaustive treatment, and while close attention is given to the more settled and hackneyed phraseology of the older branches of work, the newer words and the novel departments they belong to are not less thoroughly handled. Every source of information has been referred to, and while libraries have been ransacked, the note book of the laboratory and the catalogue of the wareroom have not been forgotten or neglected. So far has the work been carried in respect to the policy of inclusion, that the book has been brought down to date by means of an appendix, in which are placed the very newest words, as well as many whose whose rareness of use had consigned them to obscurity and oblivion. Electrical terminology presents a remarkable spectacle of accretion, and the dictionary would be interesting, if for no other reason, as an instance of the manner in which modern science and invention are expanding and modifying the language.

One of the features of the Houston dictionary is that it is not a mere word-book. For some reasons it deserves rather to be called an encyclopædia than a dictionary, which is usually supposed to content itself with brief definitions. To a certain extent the conditions forbid the author to limit himself in that manner. Thus, for example, with the word "armature," it is desirable that a fairly full explanation of its various meanings and uses shall be given; otherwise, the reader is apt to be confused instead of enlightened. Prof. Houston has decided to err, if he err at all, on the generous side, and hence he devotes also as many as 7 pages to the block system for railways; 10 pages to the voltaic cell, with a number of subdivisions; 8 pages to "circuit;" 12 pages to the dynamo; 5 pages to units of power; 12 to "galvanometer" and 19 to the telegraph. This, it will be admitted, is a liberal allowance, open to the criticism once made against Littré's dictionary, that it was dangerous for a busy man to use, because "one lingers and expatiates in it and feigns to oneself plausible reasons for looking out another word." The scheme of treatment, in short, is as follows: 1st. The words, terms, and phrases are invariably followed by a short, concise definition, giving the sense in which they are correctly employed. 2d. A general statement then follows of the principles of electrical science on which the definition is founded. 3d. When, from the complexity of the apparatus, or from other considerations, it has been thought desirable to do so, an illustration or diagram of the apparatus is given. 4th. To facilitate study, an elaborate system of cross references has been adopted, so that it is as easy to find the definitions, as the words, and aliases are readily detected and traced. In applying these rules, great care has been exercised to secure clearness, to the end that while the definitions and explanations shall be satisfactory to the expert electrician, they shall also be simple and intelligible to those who have had no training at all in electricity or are novices in the art. This is work of some difficulty, but Professor Houston has successfully achieved his purpose. No one will regret the detail into which he goes, but, on the contrary, in view of the fact that so many of his definitions are new and are not to be found elsewhere, in any form, every one will be glad that the latest terms in vogue in the most recent applications come in for elaborate, yet "popular," treatment. It is possible that disappointment may be felt at the absence of one or two definitions. The writer remembers that when an etymological Scotch dictionary was brought out a few years ago it was suggested by one serious critic that it ought to have contained a historical disquisition on the word "farintosh," a notable brand of whiskey; and so, too, it may be that in one or two instances fuller information will be desired in this dictionary. On the whole, however, Prof. Houston's judgment has been remarkably sound, and his own original work, supplemented by that of the experts whose assistance he is prompt to acknowledge, practically covers the ground, furnishing just what is needed. Objection may, of course, be raised to certain opinions expressed in the book, but that is a matter between the author and the individual reader. Thus some will think that Prof. Houston has gone out of his way to avow his belief in Reis's priority as inventor of the telephone, and in other cases, to abstain from any consideration of priority. But these questions, after all, are aside from the main one, and do not affect the incalculable value of the work as a ready book of reference on everything connected with electrical science and application.

A word will not be out of place regarding the illustrations. These, numbering no fewer than 400, have been specially prepared for the work and add immensely to its usefulness. In some sections, such as that on types of dynamos, or that on armature winding, where a clear understanding of the subject is slowly arrived at, they are profusely used, and the idea is so graphically presented that no one can fail to grasp it. So, too, with various instruments and pieces of mechanism, the cuts, while well subordinated to the text, are helpful, and will enable the untutored reader to know the apparatus the moment he sees it.

It was remarked above that there was no place where this dictionary should not at once find a hearty welcome and appreciation. To the public using electricity every hour of the day for almost every conceivable purpose, yet mystified by the extraordinary terms which describe its nature and functions, the dictionary will be one of the greatest of boons. It will be not less a benefit to the electrician, who is now given an authority to appeal to, and who has here concentrated, like Liebig's extract, the meat of many volumes and of a voluminous periodical press. But it is easy to conceive that it should be most helpful to the student, at home or at college. Its advantages, for example, in the class room where instructors employ the lecture system, are apparent at a glance. It will save the student the trouble of taking laborious notes continuously, and will thus, economizing time as well, enable him to devote his entire attention to the topic under discussion by his professor. The words and phrases in the dictionary being alphabetically arranged, the student needs only to jot down the unfamiliar expression, and after class he can look it up at his leisure. This plan was tried recently, with the aid of advance proof sheets, in a course of lectures at Philadelphia, and was found to answer admirably. Another advantage in this use of the dictionary is to be found, moreover, in the freedom it confers on the lecturer to map out his own course in the topical arrangement and to pay special attention to particular branches of the subject.

The dictionary is a handsome book, bound in red, with a stamped cover and rubricated edges. The typography is excellent, being large and bold, and so arranged that each word catches the eye at once by standing out in sharp relief from the page. The volume is convenient in size, and the binding and paper are perfect. In a word, the mechanical production of the book has been given special attention, and no cost has been spared; but it is placed within the means of all who have an interest in a great, new and fascinating department of modern knowledge and discovery.

T. C. Martin.

Quarterly Meeting of the New England Electric Exchange.

The regular quarterly meeting of this organization, writes our New England correspondent, was held in the rooms of the Boston Electric Club on Monday afternoon, the 8th inst. Among those present were the following: P. H. Alexander, president; H. B. Cram, secretary; Prof. W. A. Anthony, Frank Ridlon, D. Killecut, W. S. Hill, S. Elder, Mr. Maguire, H. Wirt, J. Y. Bradbury, G. F. Curtiss, S. A. Wade, Jr.,; E. A. Babbett, D. L. Mitchell, A. P. Wright, W. S. Key, A. C. Shaw, A. Robeson, Hon. F. A. Wyman.

After calling the meeting to order, Mr. Alexander, the President, stated that the exchange had been incorporated under the laws of the Commonwealth of Massachusetts, that the bill for the incorporation had been signed by the Governor of the State on May 21, and the seal of the commonwealth was attached to the document on May 22. The officers of the old exchange had been elected as officers of the new exchange, and it was necessary now to dissolve the present exchange and to transfer the property and franchises of the old exchange to the new organization. The total number of applicants for licenses had been 209, and one for re-examination. The total number of licenses granted and certificates issued was 169, and the total applicants rejected, eight, twenty-seven applications being still on file. The Boston Board of Underwriters had refused to grant any insurance policies on property in which electric light plants are operated unless the person in charge has obtained a license from this exchange. The New England Insurance Exchange had asked the directors to name a date when they may insert a similar clause on policies issued on property throughout New England.

Mr. Cram then read the treasurer's report, and thereafter the business of the old exchange was duly discontinued, and the funds and property transferred to Mr. Cram, secretary of the New England Electric Exchange, as incorporated.

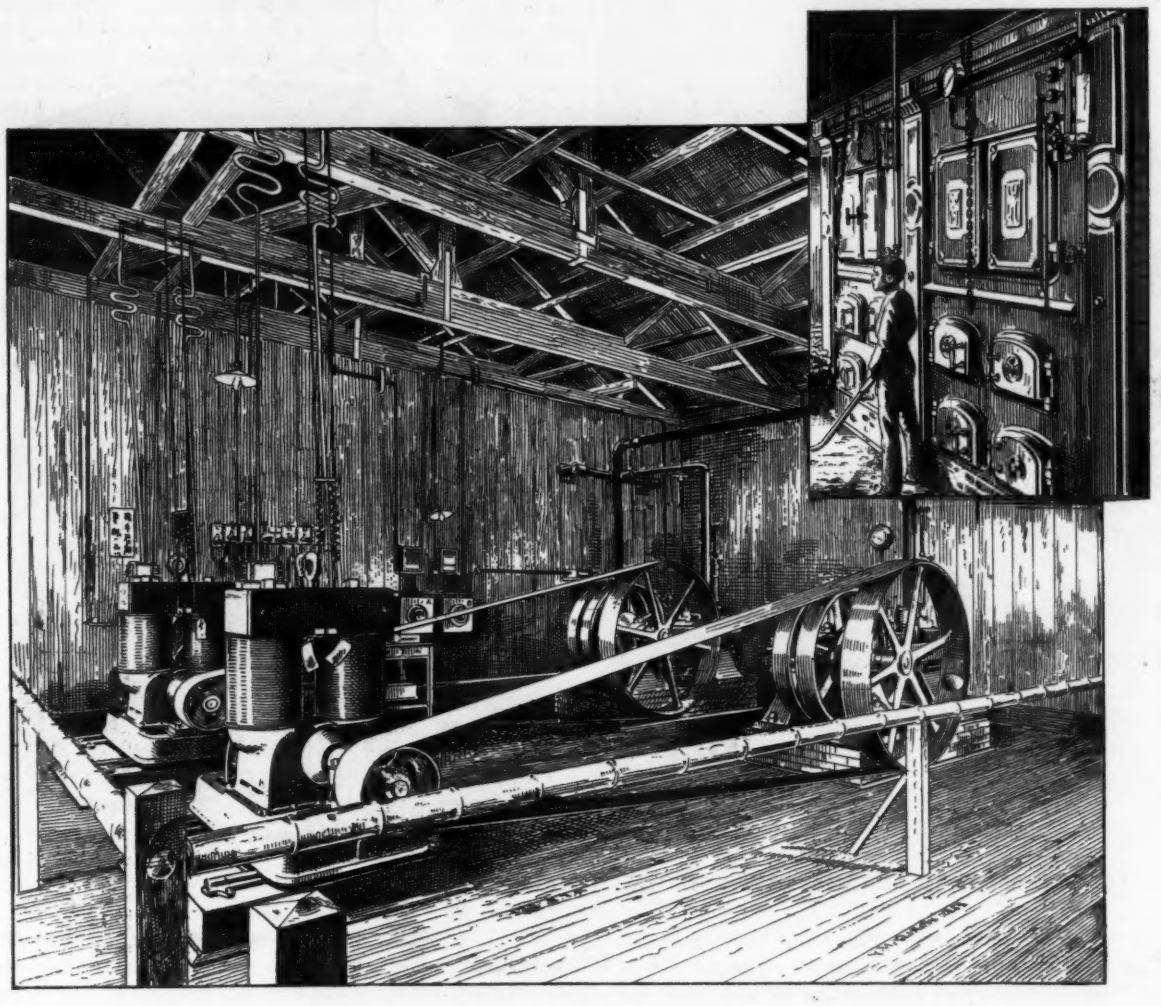
Mr. Cram drew the attention of the meeting to the fact that the licenses issued by the exchange were valid for one year only, and invited discussion on the question, "Is re-examination necessary or not?" After some discussion by Messrs. Wright, Ridlon, Blake and Hill, Mr. Cram finally moved, "That licenses may be extended for one year at the discretion of the board of directors, and the approval of the insurance inspectors upon payment of $2, the regular license fee." Mr. Ridlon seconded the motion, which was carried.

In order to curtail the length of time necessary for the examination of each candidate, Mr. Wright, after various suggestions from others, moved that the following questions be printed and added to the already existing application blank: (1). Present employment. (2). Duties of the employment. (3). Preparatory education for electrical work (concise statement of same). (4). Date of first employment. (5). List of several positions held. (6). Concise statement of work and experience. (7). Furnish such references as you may obtain from persons by whom you have been employed. The motion was carried.

Considerable discussion then followed on the question of dividing the fees with the examiners in order to remunerate them in part for their trouble and expenses, but finally it was voted that the work of the examiners should be entirely gratuitous. The general feeling was that the examiners had to devote a large amount of time to this work, and in order to arrange for more convenient meetings, nearer the headquarters of electric light men, Mr. Ridlon offered the use of a room free in his office for the next examination. Mr. Ridlon then moved that the New England Insurance Exchange be notified that the Exchange is ready to examine all applicants before Nov. 1, and that they should name that day as the date after which no building shall be insured except the plant be operated by licenses of this Exchange. The motion was carried and the meeting was then adjourned.

A Japanese Electric Light Station.

The Japanese have shown themselves highly appreciative of electric lighting, and have not been slow to recognize the special merits of American systems. During the last year or two the industry has made rapid progress in Japan, and the outlook is of a most hopeful and encouraging character. At the present time, for example, more than 5,000 incandescent lamps are burning in Tokio alone, current



A TOKIO, JAPAN, ELECTRIC LIGHT STATION.

being supplied from four central stations; and a great many lamps are being added every week. Each of the stations, on the Edison system, has a capacity of from 2,000 to 3,000 lamps, and they are all in charge of Professor Fujioka, an estimable and talented gentleman well known in this country. One of the stations we illustrate on this page from a photograph recently received from Tokio; and the characteristic touches of the bamboo railing and the native stoker will at once be noted. Professor Fujioka reports that everything is going on very nicely and that great satisfaction with the service is felt everywhere. The company have lately installed 2,500 lamps in the Imperial Palace. The construction of two more stations is now seriously contemplated, and the work on them will soon begin.

Reduction of Government Telegraph Rates.

It is the duty of the Postmaster-General to fix the rate of telegraphic service for the government. The law stipulates that he shall do it annually. From the time that the law was passed in 1866, one cent per word for dispatches of twenty words and one cent for each additional word, with 10 per cent. added for service for distances over each 1,000 miles, has been the usual allowance. Each dispatch of less than twenty words costs 20 cents. When the blanks for ordering service for the fiscal year were submitted to Postmaster-General Wanamaker during the last week in June he filled them out with "one mill per word," instead of the customary one cent, and affixed his signature in due form.

The effect upon the telegraph corporations affected—the Western Union and the Postal—was stunning, but an examination of the statutes left no possible doubt of the Postmaster-General's technical right to fix any rate he chose. Abundant reasons appear in the laws to justify such power, the telegraph companies being granted the right to construct, maintain and operate lines through and over military or post roads or any portion of the public domain, and to take from such lands all stone and timber they may need for construction purposes. In return they must give priority to government dispatches over other business "at such rates as the Postmaster-General shall annually fix."

The reduction was made in time to take effect on July 1, and the government messages sent since that date are supposed to be sent at the new rate. When asked about the matter last week in New York, General Superintendent Emerick, of the Postal Telegraph Company, said: "In common with the Western Union, we received notice some time ago of the intention of the Postmaster-General to fix a new non-paying rate. In one way it does not mean very much to us, as the average cost of the government service over our lines is only about $200 a month. If the new rate is persisted in, we shall transact government business free, as it would not pay us to keep accounts and have the bother of collecting the money."

President Chandler, of the Postal Telegraph Company, said that heretofore the government had been content to pinch the tail of the telegraph dog, but this time it had cut it off close behind the ears. The loss on each message would be many times greater than the amount received in each case. With regard to the privilege derived from the government, it had never been of any value to the Postal Telegraph Company. The right of way did not save the company from paying rent to private parties even on post roads, government timber was not suitable for telegraph poles, and they did not build anything with government stone. In Mr. Chandler's opinion the new rate was simply an illegal tax levied on telegraph companies. It was true that the Postmaster-General had the right to fix the rate, but he believed that the Constitution of the United States prohibited even the government from confiscating the property of private citizens without compensation.

President Norvin Green, of the Western Union, stated that the matter was under negotiation between himself and the Postmaster-General, and nothing would be made public until these negotiations had been concluded.

Vice-President Van Horn, of the same company, said: "There has been no meeting of the directors, so far as I am aware, since the circular came from Washington announcing the new rate. The average cost of messages in the Western Union is 24 cents. At the old rate government business barely paid. I cannot say what the annual cost of government telegraphing, exclusive of the signal service, is on our system, but it is more than $20,000."

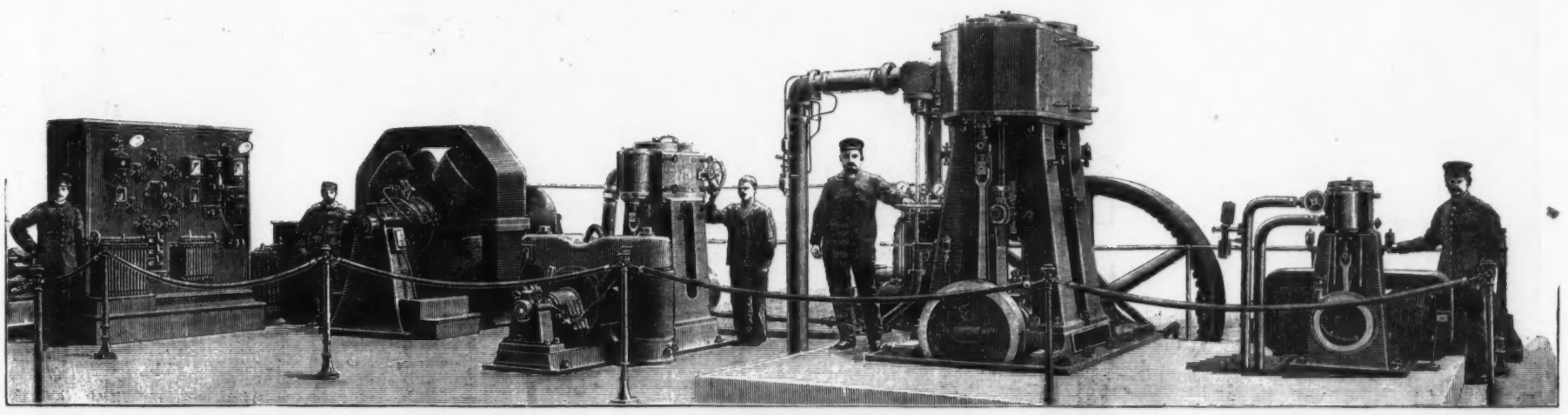
The Schoop Accumulator.

The chief object aimed at in the Schoop accumulator, which is manufactured at the well-known Oerlikon Works is to attain durability, even when the cell is subjected to excessive charges and discharges. The grids, which are of triangular section, contain two-thirds the amount of litharge usually employed. It is said that with these plates there is no trouble from buckling or from the plugs falling out. The smallest-sized cells contain 11 plates, 2.5 millimetres thick and 14 centimetres square. The total weight of a complete cell is 7 kilogrammes, the plate weighing 4.5 kilogrammes. When discharged at the rate of 10 ampères and 35 ampères their capacity is respectively 50 ampère hours and 32 ampère hours. The cells may be then discharged at any rate up to 70 ampères without sensibly diminishing the capacity.

Exhibit of the Oerlikon Works at the Paris Exposition.

One of the most interesting and best arranged electrical exhibits at the Paris Exposition is that of the Oerlikon Works, of Zurich, Switzerland. We have already described the various apparatus designed for this company by their engineer, Mr. C. E. L. Brown, and will therefore confine ourselves to the exhibit as a whole, as illustrated in the accompanying engraving, for which we are indebted to the *Engineer*. Here we find on the extreme right a new type of combined engine and dynamo for steamships, which is shown enlarged in Fig. 2. The machine, of 20 h. p., is specially designed with a view of preventing any magnetic effect on the ship's compasses, the field being so arranged that the armature pole pieces and coils are entirely inclosed by iron, which acts as a shield to prevent the dispersion of the magnetic lines of force.

The combined engine and dynamo of the well-known Oerlikon type, shown in the centre of the exhibit, is of

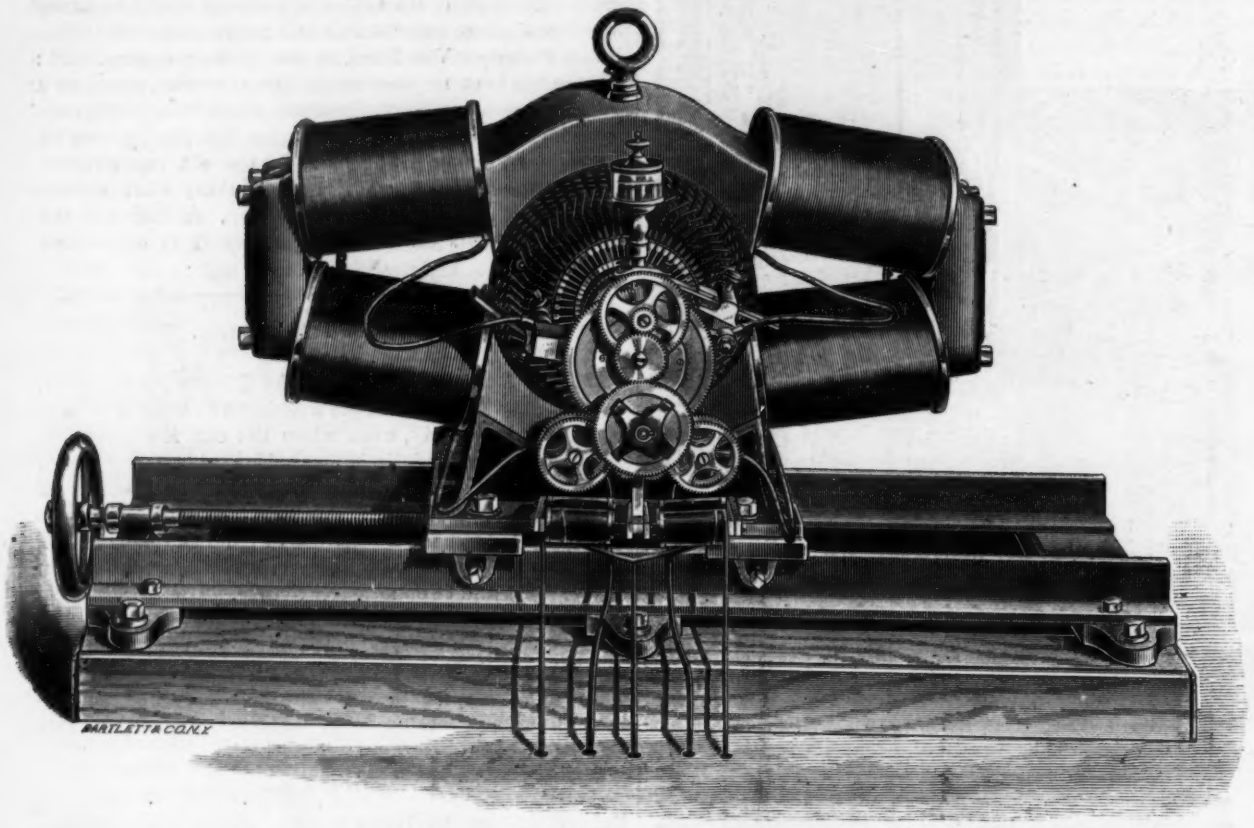


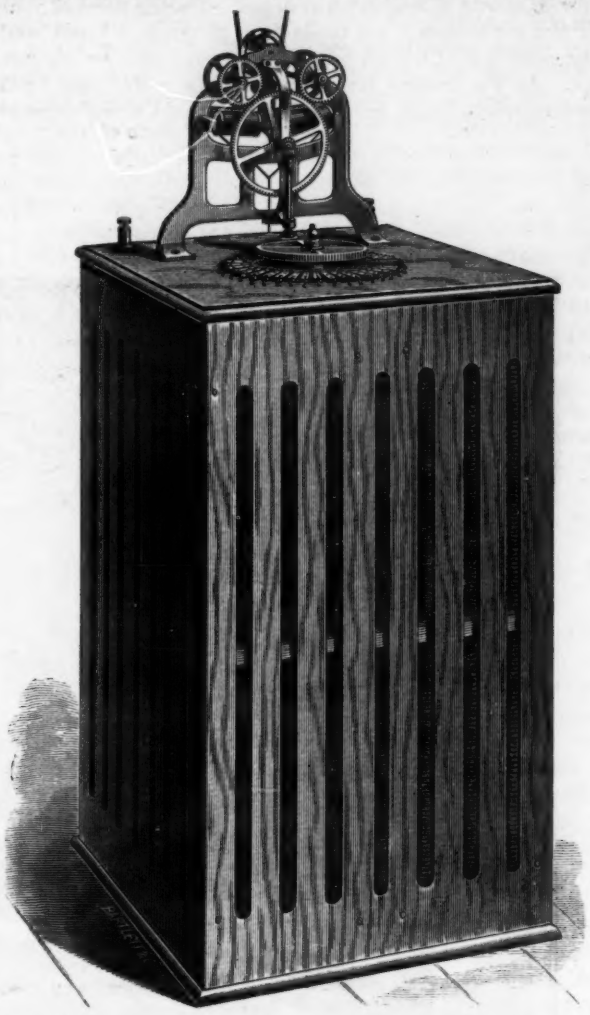
THE OERLIKON EXHIBIT AT THE PARIS EXPOSITION.

60 h. p, and serves for the lighting of the galleries. Immediately next to the switchboard is a 250 h. p. dynamo, which is driven by a belt from the large compound vertical engine, shown next to the ship dynamo. This dynamo is a 4-pole 600-volt direct current machine, and furnishes current to a motor which is erected in another portion of the Swiss section, exactly the same size and type. The energy taken off the motor shaft is close on to 200 h. p., and the speed of the motor does not vary more than 3 per cent. between maximum and minimum loads. The switchboard shown at the extreme left contains the various switches, cut-outs and regulators for governing the various circuits and machines, and are of the construction already illustrated by us. The exhibit as a whole presents a very striking appearance, and the entire work shows careful designing and neat execution.

The Knowles System of Storage Battery Distribution.

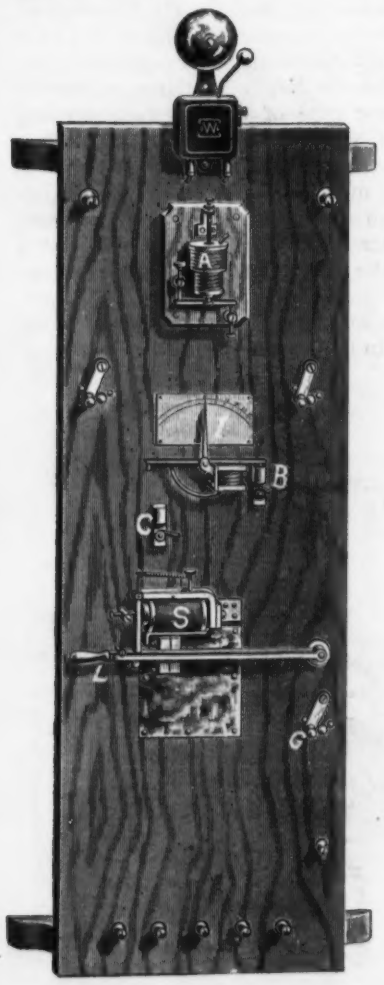
We have from time to time made note of the work of the Mutual Electric Manufacturing Company, of Brooklyn, in the system adopted by them for the distribution of current for incandescent lighting by means of storage batteries located at various points, and charged from a central station by means of high tension currents. This system, which has been elaborated by Mr. Edward R. Knowles, the electrician of the company, has now been in operation for some time, and a more detailed description of it will therefore be of interest to our readers, as it embodies quite a number of interesting data in connection with this method of distribution. Of the several plants in operation, one of the battery stations, that at No. 187 Montague street, Brooklyn, will be sufficient to bring out the methods employed.

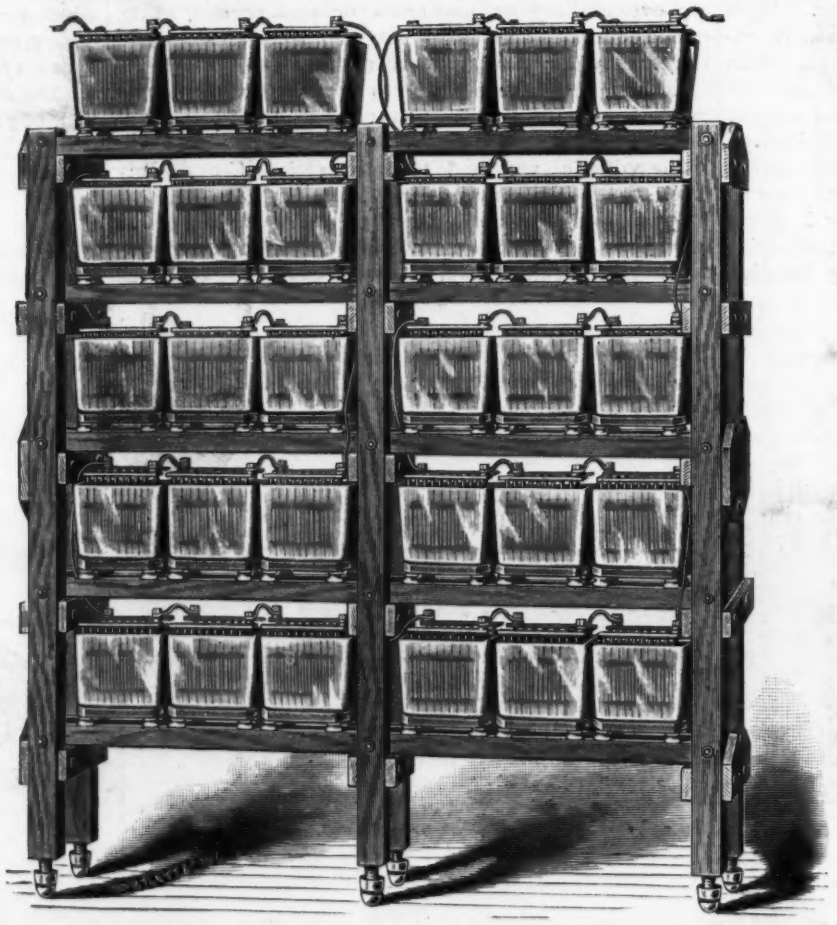


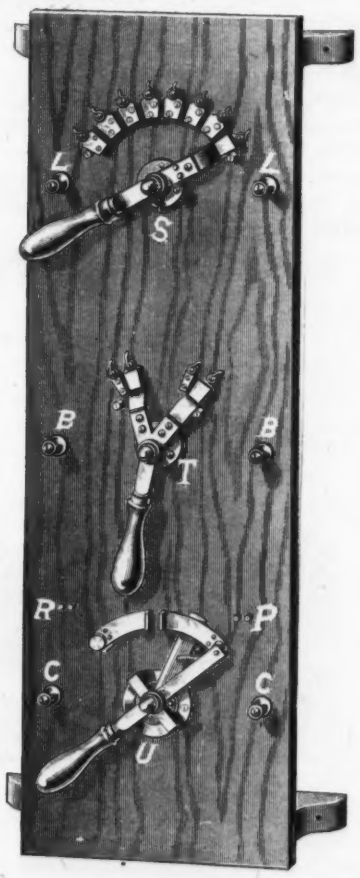


FIGS. 1 AND 3.—THE KNOWLES SYSTEM OF STORAGE DISTRIBUTION—DYNAMO AND RHEOSTAT.

Beginning with the charging station, we find here boilers and engines with a capacity of 200 h. p., operating 10 dynamos of a capacity of 15,000 watts each. For the proper charging of storage batteries, it is, of course, necessary to maintain the current at its proper strength, and for this purpose the dynamo shown in Fig. 1 is provided with a regulator, which is shown in detail in Fig. 2. The regulation of this machine is effected automatically by means of the regulator, which operates to shift one of the brushes, so as to maintain the current constant at all times. The regulator, as will be seen, consists of a nest of gear wheels, upon one of which the regulating brush is mounted, and which is revolved in one direction or the other by the action of the armature shown suspended between the two small electro-magnets on the base of the machine. These magnets are normally not energized and are under the control of the wall regulator shown in Fig. 2 at *A*. This regulator consists of a solenoid carrying a core and contacts, and is so arranged that on the normal current passing, the cross-piece attached to the core is out of contact with either of the stops shown. On an increase or decrease in the current from the normal, the wall regulator sends a current into one or the other of the magnets on the dynamo, which shifts the armature between them correspondingly and starts the gearing which moves the brush in the direction to bring the current to its normal value.







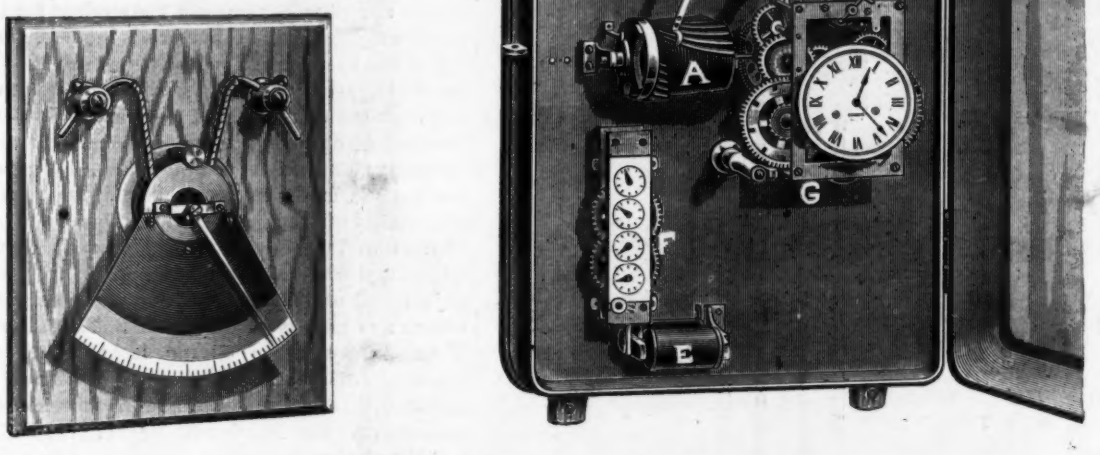
FIGS. 2, 4 AND 6.—WALL REGULATOR, BATTERY RACK AND BATTERY CHARGING BOARD.

In the operation of dynamos for the charging of storage batteries, some means must evidently be provided for preventing the reversal of polarity in the dynamo, and also the prevention either of an abnormally large current or too weak a current. This is effected by means of the apparatus shown at *I*, and mounted on the same board as the regulator Fig. 2. This consists of a small current regulator carrying an arm, arranged so as to make contact at the points *B* and *C*. With the normal current passing, neither of these contacts is made; but any abnormal condition either one way or the other causes the arm to strike one of the points *B* or *C*. The effect of this is to energize the magnet *S*, mounted on the same board, which releases the catch, and allows the switch lever *L* to fall, thereby breaking the main circuit. The lever *L*, in its fall, strikes the small switch *G*, shown below it, so as to shift the latter, causing it to close a circuit and start the call-bell ringing, shown at the top of the board, which immediately warns the attendant of the fact.

In practice Mr. Knowles starts the charging machine on a resistance contained in the rheostat shown in Fig 3, and as the batteries are switched on in succession, the automatic regulator shown at the top of the rheostat switches resistances out to correspond with the battery inserted. When this regulator is employed, that on the dynamo is usually dispensed with.

At the present time there are run from this charging station ten circuits, each machine feeding seven sets of batteries of thirty cells each, or 210 cells for each machine. From the charging station the current is carried to the battery station, in Montague street, over arc light wires placed on poles, the distance being about half a mile in this case, though one of the stations projected is more than a mile distant from the charging station

The battery station in Montague street is situated in the cellar of the building, and occupies a space of 25 by 60 feet. At the entrance is a small office, which opens out into the main battery room, in which the cells are arranged in racks in the manner shown in Fig. 4. These racks which are of wood thoroughly covered with insulating paint, rest on glass insulators and each of the cells rests on a base supported by porcelain knobs. Each of the racks contains 30 cells, as a rule, one or two additional ones be ing added, in some instances, in order to compensate for the drop in potential on long distributing lines. These cells, though capable of sustaining a charge of 20 ampères, are nevertheless charged at the uniform rate of 15 ampères throughout their charging period. The object of this will become apparent when we consider the fact, that in order to obtain the best returns from the cells it is better to charge at a maximum rate at the start, and gradually taper off in current strength towards the end.



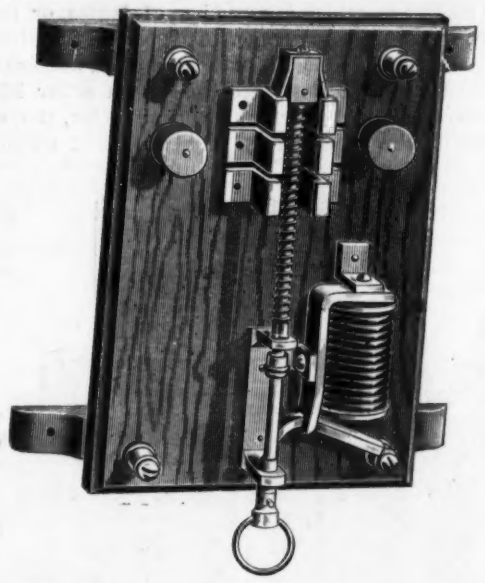
FIGS. 7, 9 AND 8.—VOLTMETER, METER AND BATTERY SAFETY CUT-OUT.

As this would require a constant attendance, and also take a somewhat lengthened period of time in order to obtain the full effect desired by this method of charging, Mr Knowles, as above stated, charges at the uniform rate of 15 ampères throughout.

At the rear of the battery room is another containing the station switchboard and the battery switches, Fig. 5. The main switchboard is so arranged that any combination of circuits can be effected by cross-connection by means of flexible cables and plugs. One of the battery charging boards, shown at the right in Fig 5, is shown in detail in Fig. 6, and embodies several interesting points. Upon this board, it will be seen, are mounted three switches, *S*, *T* and *U*, opposite to which are placed the binding posts, *L L*, *B B* and *C C*, respectively. Each series of 30 cells is connected to one of these boards, the function of which is as follows: The battery is connected to the binding posts *B B*, the lighting circuits to the posts *L L*, and the charging circuits to the posts *C C*. When it is desired to charge the battery, the attendant inserts a plug switch into the two sockets, *R*, which are connected to the terminals of the battery, and ascertains the difference of potential existing at them. He then withdraws the voltmeter cords from the sockets *R* and inserts them in the sockets *P*, which are in connection with the charging terminals *C C*. The switch *S* passes over a series of contacts of a rheostat. This the attendant turns until the potential measured on the voltmeter, now inserted at *P*, indicates the same number of volts as that indicated before at *R*, that is, that at the the terminals of the battery. When this potential is indicated, the switch *U* is thrown over to the other side, which shifts the charging current from the resistance on to the batteries. In this way the batteries are started into operation by a current of exactly the right potential, thus avoiding a rush of current in the reverse direction back to the dynamo, or too great a current.

The voltmeters and ammeters used in the station are of the design shown in Fig. 7, and are of the repulsion type, the scale divisions being practically equidistant over the entire range. The instrument is so constructed that it can be set up and the pointer brought to zero independent of the position of the board itself. At the point where the charging circuits enter the building, there is placed the safety cut-out shown in Fig. 8. This cut-out is designed to prevent the battery from being short-circuited outside the station. The magnet shown attracts the armature and allows the switch to be tripped up, whereby the batteries are cut out of circuit, and the main circuit remains closed on itself, thus preserving its continuity.

From the battery station circuits are run overhead in various directions directly to the rear of the buildings to be lighted, usually running along the inside of the block. The buildings are wired in the usual way, and at the entrance to each there is placed the meter recently designed by Mr. Knowles, shown in Fig. 9. In this meter the designer has sought to embody at once an apparatus which should be simple in construction and accurate, and, at the same time, one which shall give its indications direct, so as to permit the consumer to read off at all times the quantity of current consumed by him. The meter consists essentially of a clock-work which at stated intervals revolves a device, which, in connection with a current indicator, operates a register giving the number of ampère-hours or lamp-hours direct. Examining the details of the meter, we find a current-indicator device consisting of a solenoid *D*, which acts upon a magnet core, and shifts a pointer to positions corresponding to the strength of the current, the end of the pointer passing in proximity to the drum *A*. This drum, which is rotated at stated intervals by the clockwork *G*, has cut upon it a series of wings or teeth. These, as will be seen, vary in length, the shortest being but a fraction of an inch and increasing in length to the other end of the barrel. It will be evident, therefore, that upon being revolved the pointer will come into contact with a certain number of these wings or teeth, depending upon its position, which, of course, is influenced by the strength of the current passing through the coil *D*. Thus, if we assume that the barrel has 30 of these wings cut upon it, when the pointer *D* is completely swung over, by a current, say, of 30 ampères, it will make contact with the 30 wings of the barrel. At every intermediate position the number of contacts will be correspondingly less, and with no current passing, the pointer will be clear of the barrel at the right, so that no contact



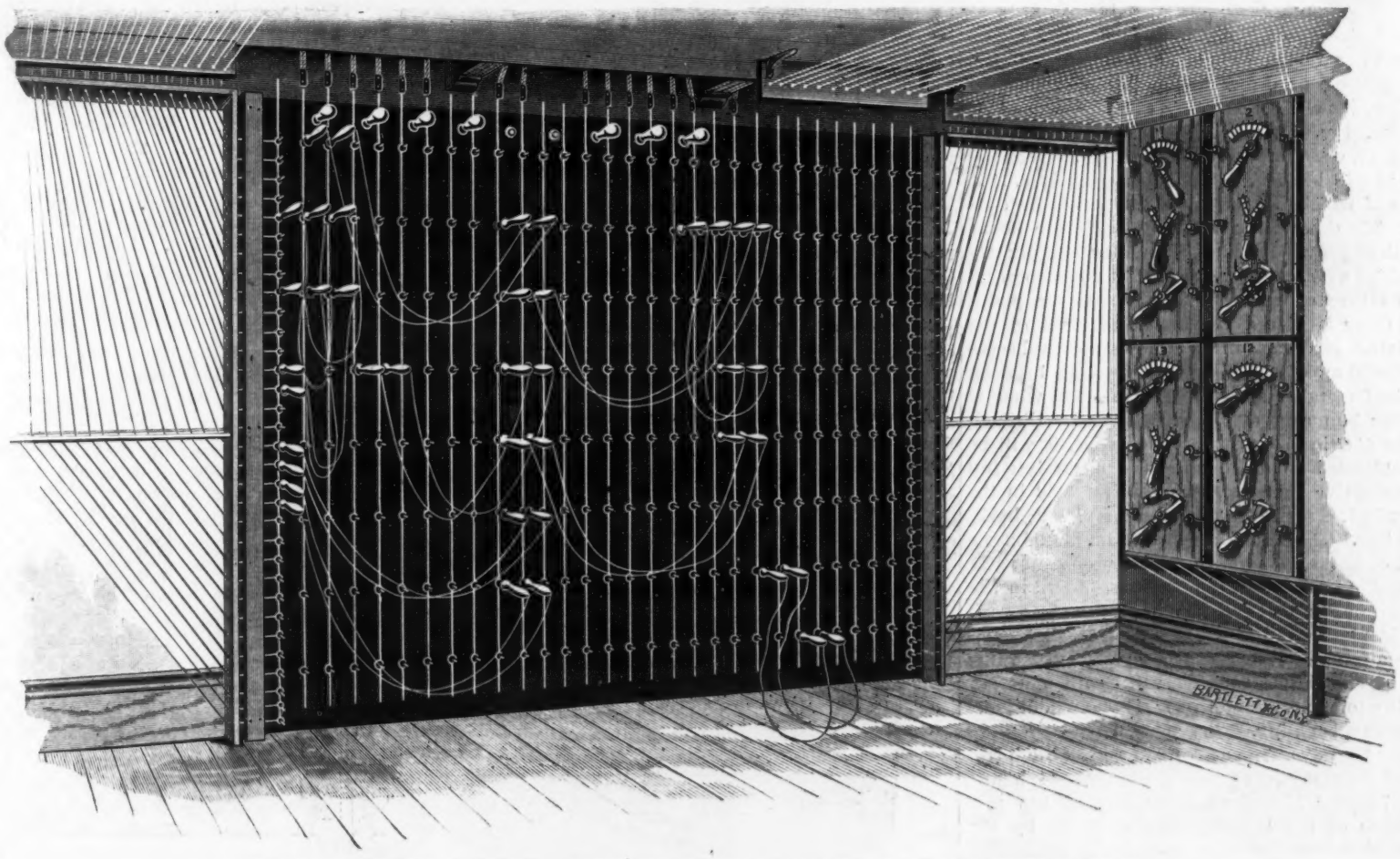
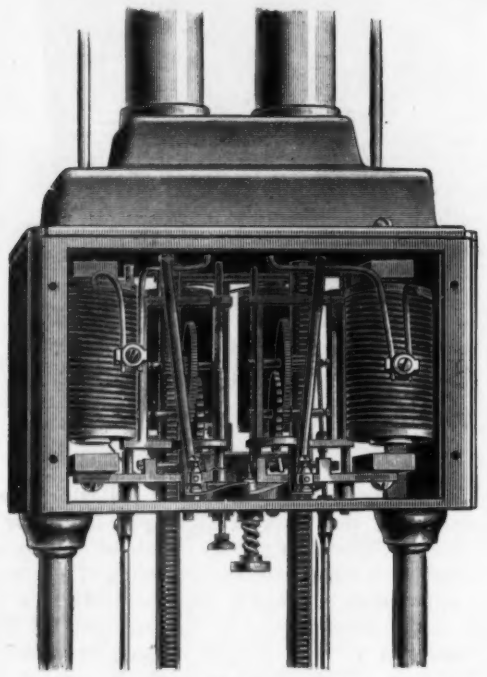


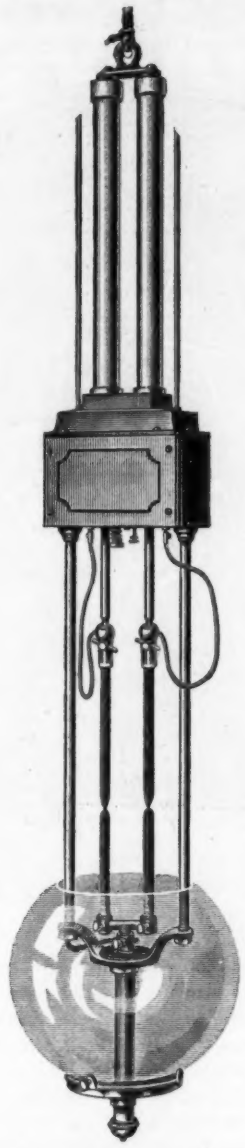
FIG. 5.—BATTERY SWITCH BOARD IN MUTUAL ELECTRIC STATION, BROOKLYN.

whatever is made. Now each contact made by the pointer closes the circuit of the magnet *E*, which operates the register *F*. Thus it will be evident that if the barrel is revolved, for example, once in each hour, the register would indicate directly in ampère hours.

In order to avoid the shifting of the pointer on the barrel from its true position, while the barrel is revolving, the magnet *B* is provided, which becomes energized the instant the barrel begins to revolve, and by means of which a brake is applied to the spindle supporting the pointer, which locks the latter in position during the time that the barrel revolves and immediately releases it at the end of the revolution. It will also be noted that the barrel is divided longitudinally by a series of lines corresponding to ampères or lamps, and by the position of the pointer with respect to which the number of lamps or ampères can be read off at any time. The barrel, therefore, discharges the same function as the dial of an ampère meter.

We have thus far described the system of Mr. Knowles without specific reference to its prime factor, the storage battery itself. Based on the experiments of a number of





FIGS. 14 AND 15.—DOUBLE LAMP AND LAMP MECHANISM.

years, Mr. Knowles has adopted a type of battery embracing several novel features in its construction, and has avoided all pasting or direct application of the active material. The Knowles cell is shown complete in Fig. 10. The engraving, Fig. 11, represents a front view of the plate and Fig. 12, a section through the centre.

The plate, as will be seen, consists of two halves, *A A* and *B B*, one of which, *A*, is cast with feet and the connecting lug. The other plate *B* is cast with the hooks *H H* and with edges which, when the plates are put together are folded over, as shown in Fig. 13, so as to bring the two into intimate connection. Between the plates thus formed there is placed the active material in the form of a plate. The active material is compressed separately in a special mold, and is made to fit snugly between the two walls of metal thus prepared for it. The whole is bound together by means of rivets, which pass through the five holes *C C* in the plates. The latter, it will be noted, are perforated so as to allow the electrolyte full access to the active material, which, being held in the manner described, is secured against dropping out, buckling and the like. The plates are cast of an inoxidizable alloy, which contains no mercury. When the plates and active material are complete, they are assembled in the manner shown in Fig. 10, being held in position by means of flexible insulating rods passing through the hooks cast on the alternate plates and pointing in opposite directions. The insulating rods being of elastic material, give flexibility to the cell, and thus afford an additional safeguard against buckling.

Recognizing the advantage of keeping an electric plant in operation for a maximum period during the 24 hours, the Mutual Electric Manufacturing Company has provided a system of arc lighting, also designed by Mr. Knowles, which is intended to be operated in connection with the battery system. While the arc lights are thus operated at night the dynamos can be employed during the day time for charging the batteries which deliver their current for incandescent lighting. Our illustration, Fig. 14, shows the Knowles double arc lamp, and Fig. 15 the interior view, showing the mechanism.

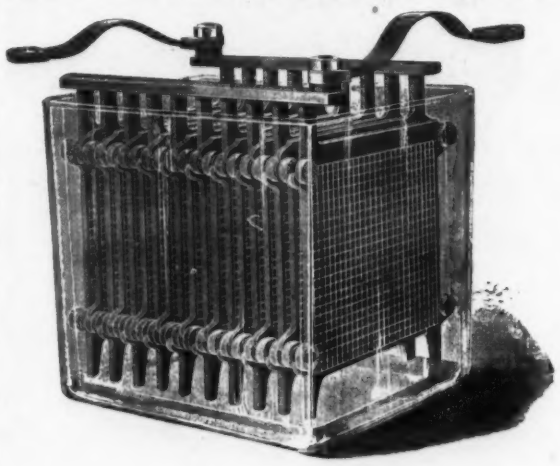
In such a combined system of arc lighting and storage battery distribution operated over the same wires, some means must evidently be provided for cutting the batteries out of circuit when the arc lamps are to be operated, and *vice versa*. This is accomplished automatically in a very ingenious way by means of a polarized switch attached to each lamp and to each set of batteries on the same circuit. This polarized switch is so constructed that a current passing through out in one direction cuts out the lamp, or battery, in circuit with it, while a current in the other direction permits the current to pass through the lamp, or battery. Now these switches are so arranged that when those on the lamps cut out the lamps, those on the batteries put the latter in circuit. The current reversal necessary to obtain this action of the switches is effected at the dynamo. Thus, during the day the switches are so energized that the batteries are charged and the lamps cut out of circuit.

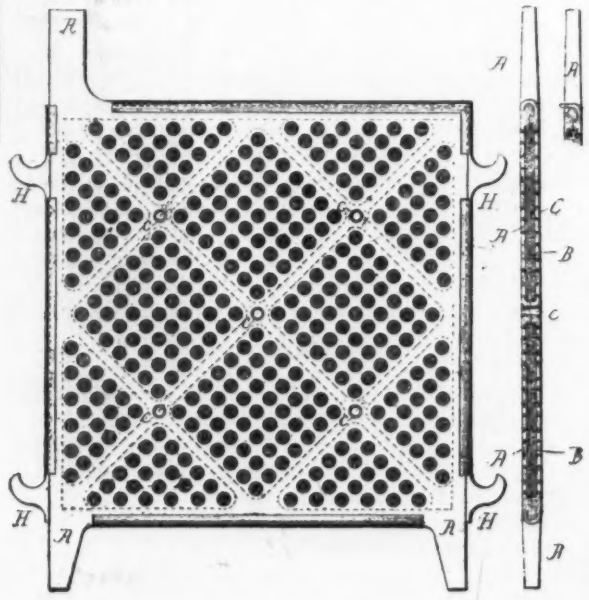
When it is desired to send current through the lamps, the terminals at the dynamo are reversed so that the current passes through the circuit in the opposite direction. This cuts out the batteries and places the lamps in circuit. In this way both types of apparatus are operated on the same circuit without interference.

The whole of the details of this system have evidently been worked out with care, and reflect great credit on their designer.

Electrical Engineering at the Ohio State University.

Another evidence of the interest taken in electrical engineering in higher educational circles is given by the new departure taken at the Ohio State University, Columbus, O., where a course in electrical engineering has been established under the direction of Prof. B. F. Thomas. A new electrical laboratory has been built, 45 by 75 feet, two stories high. The second story has a lecture room, photometer room, library and three measurement tables. The ground floor is fitted up with modern electrical apparatus. Cables run to the physical laboratory rooms in the main building, where the standard instruments are placed. A prospectus on the subject, recently issued by the officers of the University, President W. H. Scott, and Secretary Alexis Cope, says:





FIGS. 10, 11, 12 AND 13.—KNOWLES STORAGE CELL AND NEW PLATE.

"Instruction in the commercial applications of electricity has been given at the University for some years in connection with the regular work of the department of physics. The increasing interest and importance of such work was this year recognized by the Legislature, and an appropriation was made for the erection of a building and the securing of the necessary machines and instruments for a full and practical training. The building will be completed and the machinery in position at the opening of the fall term, Sept. 11, 1889.

"The course of study covers four years, and those completing it receive the degree of mechanical engineer, their diplomas stating that they have completed the course in electrical engineering. Admission to the course is given on the same conditions as to the other engineering courses of the University.

"The objects aimed at in this course are, first, to afford the student a thorough training in the theoretical principles which underlie his chosen profession; secondly, to give him skill in the use of instruments, and practice in the handling of dynamo machinery. The work in mathematics and physics prepares the student for the theory of the steam engine and other prime movers, and for the theory of the dynamo and motor, which are fully discussed in the senior year, with all the allied topics in the commercial distribution and use of electricity. In the physical laboratory an extended course is given in the theory and use of instruments in mechanics, heat, light, electricity and magnetism. In the mechanical laboratory, a general course of practical instruction in the use of hand and machine tools in wood and metal working is provided. In the electrical laboratory practical training is given in the setting up, adjustment and running of the steam engine, and of dynamos and motors of all classes. For this work, a New York Safety steam engine is provided, with dynamo machines of commercial size from the Brush, Thomson-Houston, Mather, Edison, and Westinghouse companies, motors from the Brush and Mather companies, and a 50-cell Brush storage battery. There are also provided steam engine indicators, dynamometers, and various forms of commercial electrical measuring instruments. In the physical laboratory are standards and instruments of the highest quality, with which work may be done with any desired precision."

Third Brush Regulation for Constant Current.*

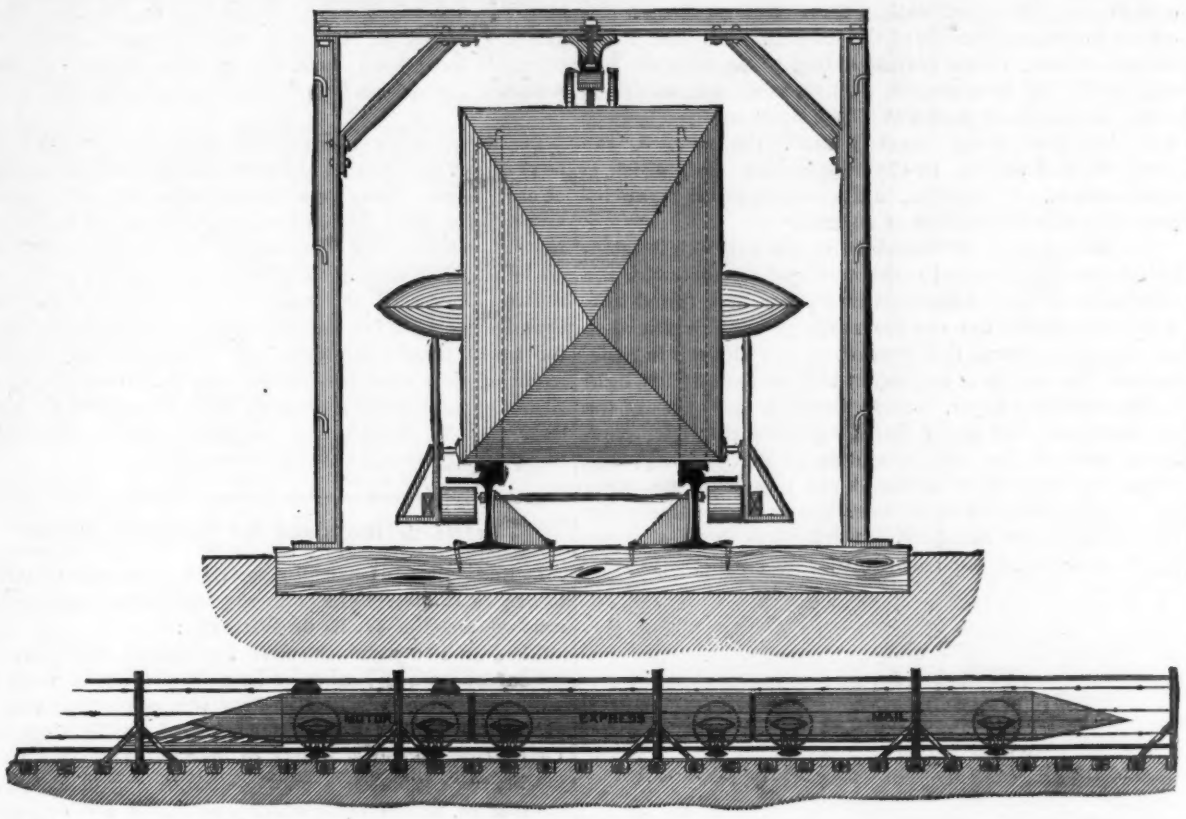
BY F. N. WATERMAN AND A. C. BALCH.

In planning a thesis on this subject it was our original intention to follow out Mr. Caldwell's suggestion, made in his thesis prepared last June, and confine our attention to the application of a third brush to motors for regulating purposes. There being no series machine in the laboratory which at the time could be used for the purpose, a five-light Waterhouse arc machine was very kindly loaned us by Mr. F. G. Waterhouse. With this our work has been conducted. The regulation of this machine, like all the smaller arc machines of the Waterhouse Company, differs from that studied by Mr. Caldwell and is even more remarkable, as regulation is attained without external mechanism. A third brush is placed slightly in advance of the upper main brush and is connected through a resistance to the end of an extra resistance inserted in the circuit of the field and main brushes. By adjusting these resistances a point of regulation is found. We determined, inasmuch as this method has not been investigated here, to include a study of this method as a prelinary to our work on motors. It was found, however, that the field laid out was more extensive than could be covered thoroughly, so the work has been confined to dynamo regulation.

It has been found that when with a given lead of the third brush certain resistances are placed in the field and third brush circuits, the current in the field will, within certain limits more or less limited, become directly proportional to

* Abstract of Thesis.—Cornell *Crank*.

the external resistances, this being the necessary condition for constant current regulation. This regulation depends upon several conditions for a certain lead of the third brush ; there are certain definite regulating resistances, and a certain angular advance of the main brushes from the theoretical neutral point. The range of external resistance through which regulation is attained decreases with increased lead of the third brush. A careful study of the variations of the neutral point has shown that there is in all machines regulated by the third brush a wide range of shifting of the neutral point for very light loads. This evidently must be so since the field will carry almost no current while in the armature the current has its normal value.



FIGS. 1 AND 2.—THE WEEMS ELECTRIC SYSTEM OF RAPID TRANSPORTATION.

The Weems Electric Railway System.

For some time past a series of experiments have been making at Laurel, Md., on an electric railway system devised by Mr. David G. Weems, the electrician of the Electro-Automatic Transit Company, of Baltimore. The experimental line erected there has a circuit two miles in length, embracing numerous grades, some as heavy as 108 feet to the mile. Our illustration, Fig. 2, shows a train of three cars on the Weems system, placed on a roadbed which it is proposed to inclose entirely between barbed wire fences. These wires will pass through insulated slots in the iron posts and will be employed for telegraphing and telephoning, as well as for the regular railway telegraph service. The three-car train shown consists of a motor, express and mail car. The express, it will be seen, is "telescoped" into the the other two, so as to present an unbroken exterior. The ends of the train are pointed so as to offer as little resistance as possible to the air in the passage of the train.

An end view of the train and a section of the road bed is shown in Fig. 1. As will be noted, the journal bearings are placed outside of the car and enclosed in elliptical housings, and the rail has an upper and lower bearing surface. A lazy wheel is carried along beneath the lower bearing, and comes in contact with the rail only when the train rounds curves, or when there is any tendency of the car to rise on the rail.

Current is taken from a copper conductor attached to the upper frame work, the current being taken off by wheel brushes.

It is proposed to control all trains from the generating station, special appliances being provided indicating to the operator the exact location of each train.

The speed attainable with the proposed system is said to be very high, three miles a minute being spoken of.

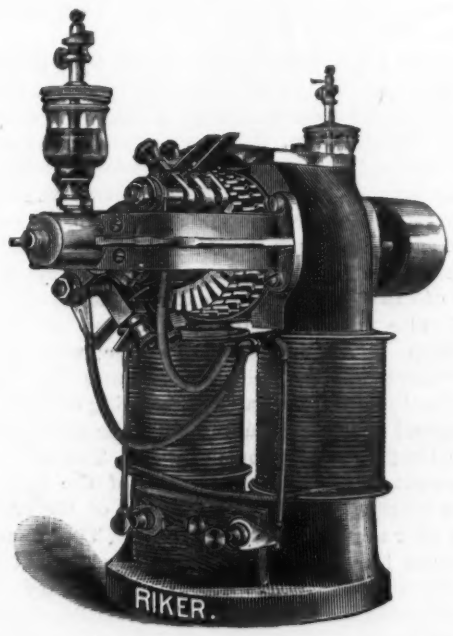
Amalgamation of Submarine Cable Interests.

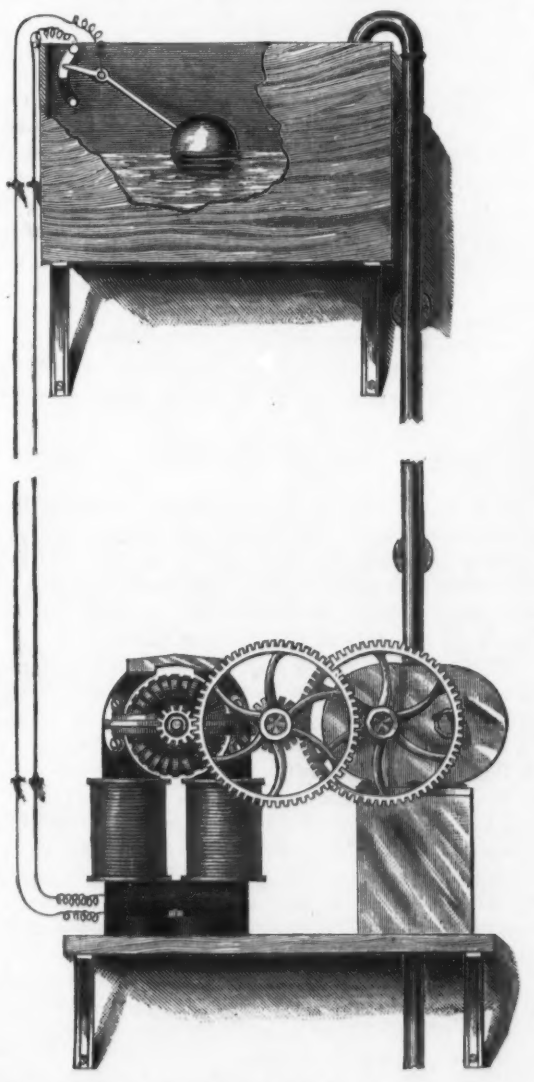
Further evidence of the close relations now subsisting between the Commercial and French cable interests is given in the following dispatch from Halifax, N. S., July 8:

"The management and operation of the French cable from Sydney to St. Pierre and thence to France has been taken over by the Mackay-Bennett Company. George G. Ward, Mackay-Bennett's New York manager, is now in Nova Scotia superintending the amalgamation. The French company's land lines from Louisburg, where the cable landed, to Sydney, have been dismantled and the cable steamer "Pouyer-Quertier," has laid a new cable from the main land at Louisburg to Fox Island, Canso. From Fox Island to Hazel Hill, Canso, the cable station of Mackay-Bennett, the distance is four miles. The Mackay-Bennett offices and the landing place of the French cable are connected with a "trench cable," that is, a cable buried in a trench four feet deep or under water. The Mackay-Bennett and French companies have entered into an amalgamation which will be a rival to the cable pool. They have, it is said, formed connections with the Canada Pacific telegraph system, and in a few weeks the Canada Pacific land lines will have completed connection with the cables at Canso. In order to have another independent connection with the United States, a new cable is to be immediately laid between Canso and Boston."

The Riker Motor.

The accompanying illustration, Fig. 1, shows the type of motor now being constructed by the Riker Electric Motor Company, of Brooklyn, N. Y. These motors are built in various sizes from ⅛ h. p., suitable for driving fans and light machinery, up to 2 h. p. One of the uses to which the motor of ⅛ h. p. can be applied is to the pumping of water, the arrangement for which is shown in the engraving, Fig. 2. The motor is capable of elevating 150 gallons per hour to a height of 50 feet; it is automatic in its action, being operated by the float in the tank as the water in the latter falls and rises. Similar apparatus is also arranged with motors of 10 h. p., also built by the company, and designed for other work.





FIGS. 1 AND 2.—THE RIKER MOTOR AND MOTOR WITH PUMP.

Recharging Exhausted Primary Batteries.

To the Editors of The Electrical World:

I am using dry batteries, and write to ask you if they could be recharged again from gravity cells? X.

ANSWER.—Without knowing the nature of the cells, it is impossible to say if they could be revived in this way. It has been suggested to recharge primary cells in this manner, but we have not heard of its being done in actual practice.—EDS. E. W.

Some Photographs of Lightning Flashes.

At the last meeting of the London Physical Society, Mr. F. Clayton read a paper on the above subject.

The author exhibited photographs which he had taken during a recent storm, and some of which exhibited the phenomenon of the dark flash. It had occurred to him that this phenomenon might be due to the action of diffused light reflected from the background behind the flash ; and in order to test this idea he had taken photographs of sparks from an ordinary machine, the sparks being allowed to pass in front of a light background. He then found that "dark sparks" exactly similar to the "dark flashes" were shown in the photograph when the exposure was sufficiently long, and he therefore concluded that the phenomenon was due to the effect of the diffused light reflected from the background, though he was not able to offer any explanation as to how the effect was produced. When the exposure was somewhat shorter than was required to give a completely dark flash, a very curious effect was produced, viz., the path of the spark was shown as a dark line with a white core, and as the time of exposure was gradually diminished the width of this core increased, until ultimately an ordinary light image was obtained. It therefore seemed that, however the effect was produced, it was one which first affected the outer edges of the image, and gradually proceeded inwards. The reversal took place more easily the less the brightness of the sparks.

In the course of the discussion which followed, Mr. W. N. Shaw exhibited a photograph taken by the Rev. Mr. Rose during a recent storm, which showed bright main flashes with dark flashes branching from them. Mr. Shaw thought that the dark flashes could not be due to overexposure, as in this case the central part would be the most exposed. One of the side flashes showed a white line along its centre, which appeared to confirm Mr. Clayton's view that the reversing effect proceeded from without inwards. Professor Perry thought that this photograph confirmed Mr. Clayton's theory, as the side flashes were not so bright as the central one. Mr. Clayton, in replying to the discussion, observed that the diffused light appeared in some manner to undo the photographic effect of the spark or flash. He did not think that Professor Stokes' theory, that the reversal was due to the absorptive effect of gases produced by a preceding discharge along the same path, could explain the existence of the unreversed core.

Storage Battery Construction.

To the Editors of The Electrical World:

1. Can I make a simple storage battery and use it without infringing. 2. Can I use the red lead? Please answer in the WORLD. S. H. M.

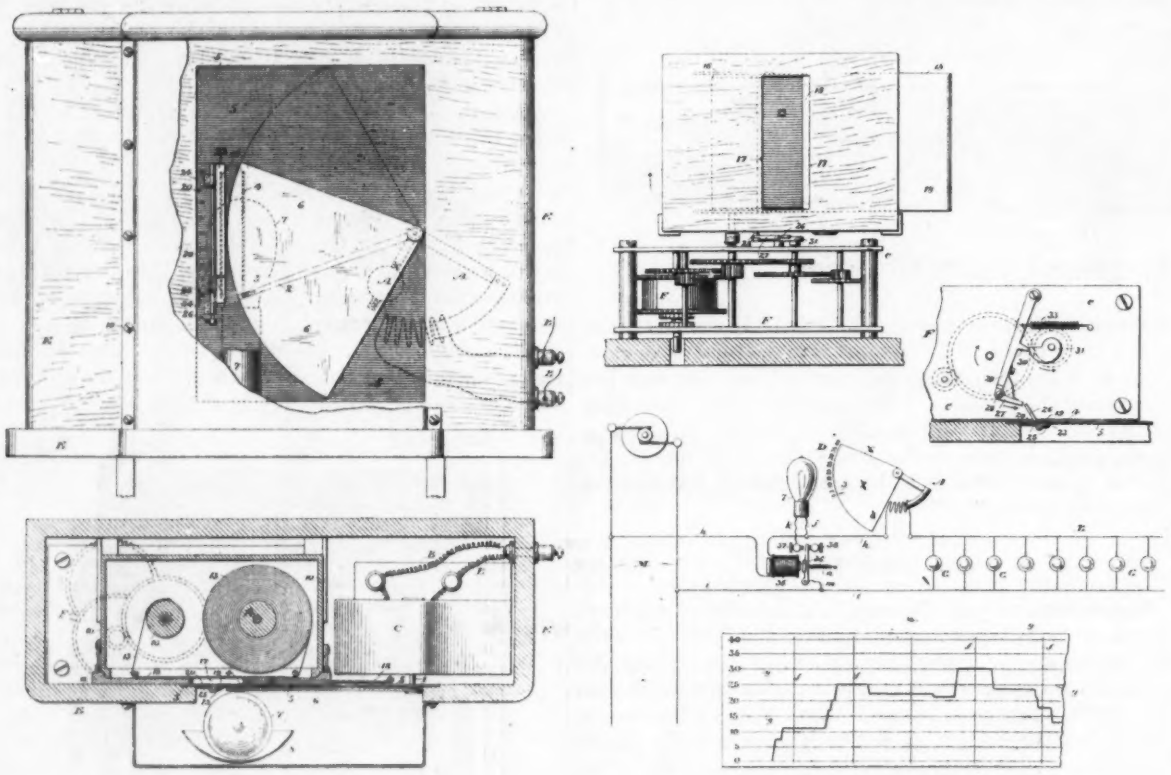
BRIDGETON, N. J.

ANSWER.—A storage battery made on the original Planté system, with the oxide "formed" electrolytically, is open to public use. We doubt, however, if you could use red lead applied to the battery plates without infringing some existing patents.—EDS. E. W.

The Walker Electric Meter.

The necessity early experienced in the distribution of electricity for light and power for a meter has led to the construction of a variety of such apparatus operating on different principles. Thus we has have the electrolytic meter, the motor meter, the differential time meter, the thermal meter, the photographic meter, etc. Of these the last type seems to have received but comparatively little attention, so that a new and ingenious form of this class of instrument, recently designed by Mr. George W. Walker, of this city, will be of interest at this time. In this instrument the indication of the current strength at all times is marked by means of a line traced on a sheet of photographic paper which is continuously passed before a beam of light, the position of which is dependent upon the current strength.

Our illustrations, Figs. 1 and 2, show the instrument in elevation and in horizontal section. As will be seen, the meter embraces an ammeter *A* included in the main circuit, and inclosed in a box impervious to light. Extending from the axis of vibration of the meter is an arm or needle 2, whose free end is arranged to swing before a graduated scale fixed or marked upon some stationary part of the machine. In Fig. 5 the scale is shown at *D*. The needle near its free end is provided with an elongated opening 3, which vibrates in front of a long straight slot 4 in a partition 5, secured in a vertical position in the box *E*. On each side of the needle is arranged a shield 6, in



FIGS. 1, 2, 3, 4, 5 AND 6.—WALKER'S PHOTOGRAPHIC ELECTRIC METER.

the form of a sector, for a purpose to be presently explained.

In front of the needle and shields is arranged an incandescent lamp 7, provided with a reflector. A cover screwed to the casing *E* is placed in front of the lamp. This cover is provided with a glass face to permit observation of the scale *D*, and the needle for the purpose of ascertaining the state of the meter at any time.

Within the box *E* and back of the plate 5 is arranged a box 10, which is designed to contain the sensitized bromide paper. This paper is wound in a coil upon a roll 14, mounted to rotate in the box 10. The outer end of the coiled ribbon of paper passes around rollers 15 at the front of the box, and is fastened to another roll 16. The front of the box has a large rectangular opening 17, Fig. 3, to expose the paper to the light from the lamp 7 when the box 10 is within the casing *E* and the apparatus is in operation. A slide is provided to close the opening 17, in order to effectually prevent the admission of any light to the sensitized paper when the box is removed from the casing for the purpose of developing or fixing the photographic impressions upon the paper. In order to conveniently insert and remove the paper, the front of the box is detachable.

The opening 17 in the front of the box is made sufficiently wide and long to encompass the slot 4 in the dividing plate 5, as well as a similar parallel slot 19, and a series of perforations 20 also made in the plate for the purpose of admitting light to the sensitized paper through the slots and perforations.

Beneath the box is arranged a clock-work *F* for feeding the sensitized paper or for winding it from the spool 14 to spool 16.

The slot 19 is normally covered by a shutter 23, Figs. 1 and 4, which is hinged to the plate 5, and which is provided with a spring 25, for a purpose which will presently appear. This shutter is automatically operated at given periods of time by means of the cam and clock-work hown, to permit the passage of light thr ough the slot 19 to obtain effects upon the sensitized paper.

By periodically admitting light through the slot 19 the sensitized paper is marked transversely, as indicated by the lines *f* at Fig. 6, and hence is divided into known periods of time.

The series of perforations 20 are always open for the passage of the light, and by this means the paper is ruled longitudinally, as indicated by the parallel horizontal lines *g* at Fig. 6. These perforations 20 are calibrated with reference to the graduations of the scale *D*. The lines *g* represent current values corresponding to the scale *D*, and may be divided into periods of five, as shown, or otherwise. In the chart shown at Fig. 6 there are nine lines *g*, the lowermost being marked zero, the next 5, the next 10, and so on to the uppermost one, which is numbered 40. These lines, in the present instance, are intended to signify ampères of current.

The straight or rectilinear slot 4 co-operates with the elongated opening 3, formed in the needle of the meter for the admission of light to the sensitized paper, and the shields 6 on either side of the eye are made of such width as to cover at all times all that portion of the slot not in register with the eye, so as to prevent the entrance of any light to the sensitized paper, except through the eye. If the eye be at zero, the upper shield excludes the light from every part of the slot, excepting at that locality, and if the eye be at 40 the lower shield intercepts the light below that point, while between the extremes of the slot both shields come into play. It will be observed that the eye 3 is made of such length that it may always coincide with the straight slot 4, no matter what the extent of vibration of the part may be.

The lamp 7 is included in the circuit *B*, as illustrated in the diagram at Fig. 5, and is arranged to be lighted only when one or more of the lamps *G* may be in use. To effect this desideratum, there is placed in the circuit an electro-magnet 35, and a spring-controlled armature which vibrates between a contact 37 and a stop 38. From one wire of the main line *M* extends one wire *h* of the circuit, which, passing through the electro-magnet and the meter, connects with the lamps *G*, and from the other wire of the main line extends another wire *i*, which also connects to the lamps *G*, as usual. The lamp 7 is connected to the wire *h* and to the contact 37, while the armature is connected to the conductor *i*. The armature-spring operates to hold the free end of the armature against the stop 38 when all of the lamps *G* are out or in disuse. The instant, however, a connection is made at any of the lamps *G* the magnet is energized, and the free end of the armature is drawn over to touch the contact 37. This immediately throws the lamp 7 into the circuit, causing it to become incandescent and to produce the necessary light for photographing the movements of the needle or arm of the meter.

Before the lighting of the lamp 7 the needle or indicating part of the meter stands at zero, but as soon as the lamp 7 is lighted, which, as explained, cannot occur until one or more of the lamps *G* are put into operation, the needle of the meter moves a distance on the scale *D* corresponding with the quantity of current being consumed. The movements of the needle will, of course, vary in accordance with the number of lamps in use, and hence will vibrate back and forth irregularly in front of the slot 4. This vibration is photographed instantly and accurately upon the traveling band of sensitized paper, and thus a positive record or representation of the same is secured.

The clock movement is geared to feed the sensitized paper at any desired speed—say about one inch per hour. As the paper is wound upon the spool 16, and the diameter is thus increased, the paper will move before the slot 4 at a slightly increased speed; but this is immaterial on account of the employment of the slot 19 and the shutter, whereby at predetermined times the lines *f* may be made without regard to the rate of travel of the paper.

After the lapse of a predetermined time, a month, for instance, the roll of paper is taken out and the photograph developed in the usual manner, and when the impressions have been fixed the amount of current used within the given period of time may be readily ascertained.

Fig. 6 represents a developed chart, from which it will be observed that during the first hour about eight ampères of current were used for a few minutes, and about eleven ampères for about fifteen minutes; that during the second hour eleven ampères continued to be used for about half an hour, when during the next ten minutes or so the current was increased in quantity to twenty-five ampères; that during the third hour twenty-five ampères were used for about fifteen minutes, and thereafter only twenty-three ampères were used, and so forth. Thus the quantity of current passing through the meter during the hour, day, week, or month may be conveniently ascertained and properly charged to the consumer.

Electric Railways and the Telephone Service.

In dissolving at Chattanooga, Tenn., the injunction obtained by the telephone company against the new electric road, Chancellor W. H. de Witt says:

Telephone companies were recognized and provided for by the laws of Tennessee long before street railways were permitted to use electricity to operate their cars.

Telephone companies, under the acts of the Tennessee Legislature, have the power of eminent domain. Being public, their property cannot be taken for other public companies, unless such other companies are organized under laws which provide that it may be done.

We are aware of no provision of law in Tennessee permitting this to be done by a street railway company. It does not appear that any statute empowers a street railway company to condemn the property of other public companies, nor does the law confer upon such companies the power to condemn the property of private persons within the city limits.

The telephone company having been in possession, under its charter and the city ordinance, years before the charter of respondent company was obtained and the right of way granted to it by the city, acquired a vested right to use the strip of earth along the line of its poles through the streets.

The ordinance granting the right of way and easement of user constituted a contract which the city itself could not impair, unless this right was expressly reserved, and especially is this so since the telephone company has accepted the grant, and is operating under it. A franchise is the legal right to use tangible corporate property in a prescribed way for profit. It is property, in a sense, and cannot be destroyed without making compensation. The law is the same with respect to easements.

The telephone company's franchise, or right to use its corporate property for the use of its chartered business, as known and recognized at the time of the grant to it, was and is a vested right entitled to be protected as "property" under the law.

Respondent company, not having the right to exercise the power of eminent domain in this case of course, cannot proceed to condemn and pay for complainant's property for the use of respondent company.

If respondent company's plan or system of operating its street cars by electricity should result in the partial or entire destruction of complainant's property, it would be liable for the damages.

Inasmuch as I am not fully satisfied that injury will result to complainant by the operation of respondent's system, and especially as it is assumed for respondent, that it has adopted for the operation of its cars by electricity, an additional precaution, which has never been adopted heretofore or elsewhere, I am content to dissolve the injunction for the present, upon condition that respondent company enters into bond with good personal security in the sum of $10,000, payable to complainant, conditioned to pay such compensation or damages as may be adjudged or decreed in favor of complainant in this cause by reason of the operation by respondent of its cars by electricity.

Fuel Consumed in Electric Light Plants.

To the Editors of The Electrical World:

Will you please inform me through the columns of The Electrical World what amount of fuel (coal) is used in practice for running a plant of, say, 200 arc lights of 2,000 c. p.; and also for 1,000 incandescent 16 c. p. per month, running, say, 12 hours per day, and every day.

By giving me some good practical figures you will greatly oblige AMPERE.

Middletown, Conn.

Perhaps some of our readers may be able to give the desired information, which we will be glad to publish.—Eds. E. W.

The Edison Three-Wire System of Distribution.

BY W. J. JENKS.

In the use of electricity for the production of light the world has realized one of the most far-reaching and commercially important of the myriad applications of this marvellous manifestation of energy. We may well pause for a moment at the outset and repeat this term, *manifestation of energy*, while we fix firmly in mind the fact that in calling forth the light of the vaporizing carbons of the electric arc or the glowing filament of the incandescent lamp we are but changing the old time energy of the sun's light and heat, long dormant in the coal we burn, back to the energy of chemical action, heat, expansive power of confined vapor, motion, magneto-electricity, heat and light once more. In order that we may more clearly grasp the salient points of comparison between the purely electrical diagrams and the water analogues to which we shall refer, it will not be out of place to rapidly review the ideas suggested by the electrical units most often involved in anyeffort at comparison.

ELECTRICAL AND HYDRAULIC UNITS.

1. *Potential:* Energy represented by a difference in the electrical condition of two bodies or points in space, as in hydraulics the difference in level of two bodies of water represents the expenditure of force necessary to place them in this attitude of contrast.

2. *Electromotive Force:* The active pressure resulting from the difference of potential, and corresponding closely with what we may call the mechanico motive force resulting from a difference in level of two bodies of water. The pressure of water is measured in pounds; that of electricity in volts.

Thus in both water and electricity we have difference of potential while no work is done. The pressure exists, and it is possible by an absolute electrometer to measure static attraction (the result of pressure where no work is done or no flow occurs) down to a few volts. Sir Wm. Thomson has recently attempted to reduce this principle to a practical form by putting upon the market an electrometer corresponding to a water or steam gauge, reading from about 400 to several thousand volts. Practically, however, we measure electrical pressure only when we make an outlet for it, and from the flow through a known resistance we calculate the fall of potential. The current being the same at all points in a perfectly insulated circuit, it is evident that the potential only is lost, or in other words, the energy which has produced the difference of pressure and been temporarily or momentarily stored up, as it were, has been expended, and the arrested motion or velocity transformed into heat. Here then is one cardinal idea, namely: Electricity is not in itself a source of energy, but a means of transference or transmission.

3. *Resistance to electrical action:* Represented by ohms, while for the friction of water in pipes we have no unit of measurement.

4. *Intensity or force of flow resulting from electromotive force modified by resistance:* Represented by ampères. For this action hydraulics has no unit.

5. *Quantity of force delivered in a given time, or ampères per second:* Expressed in coulombs; measuring a dynamic discharge as we measure gallons per second in hydraulics.

6. *Power conveyed through a conductor by the flowing of any current at any pressure or the rate at which energy is expended or work done:* This is the product of the electromotive force and the resulting current, and is measured in watts.

6. *Work done or heat generated by a current during a certain period, or by a certain number of coulombs at a specified pressure:* This is expressed in joules.

It is often convenient to compare electrical with mechanical energy by remembering that 746 watts is the equivalent in electrical units of one mechanical horse power, 550 foot pounds per second.

COMPARATIVE EFFICIENCY OF ELECTRIC LAMPS.

It it quite evident that we can only secure a lower percentage of the efficiency in a light produced by expending our power in bringing a carbon to incandescence, but still retaining its form, and for a certain time perpetuating its existence, than we can where we raise this carbon to such a heat as to speedily dissipate it. It follows, therefore, that the incandescent lamp, even considering the greater life of the carbon in the vacuum, is less efficient as a means of converting the energy of electricity to that of light than the arc lamp; and Professor Nichols has shown in a very able paper within the past few months that with the old type of Edison lamp the efficiency was about one-half of that of a standard nominal 2,000 c. p. arc. The adoption of the new type has so far increased the efficiency of the Edison lamp that we now stand to the arc lamp as 7½ to 10, or about 75 per cent.

It was the knowledge of this lesser light-producing power of an incandescent filament, coupled with the difficulty of producing currents of an E. M. F. low enough to be practically safe for domestic uses by machines of sufficient capacity to serve as factors in a centre of supply for the light of a town or city, and the great loss attending the distribution of such currents, which made the European scientists so positive, less than nine years ago, that no commercial results would follow Mr. Edison's incandescent experiments, and sceptical as to the success he finally achieved even in comparatively small isolated plants, up to the time of his demonstration at the Paris Exposition, and afterward regarding central station lighting, until, on September 4, 1882, the engines of the New York system were set in motion and electricity was for the first time commercially sold as light by electrical measuring devices.

The greatest triumph of the Edison plan is realized in its adaptation to this *central station distribution*, which is properly the subject of this paper. With this method at our command we deliver current at any point within a given district for any number of lamps within the capacity of its conductors, precisely as a gas or water system supplies its energy, and in so doing enter by far the largest field for illumination of any kind, interior spaces, and particularly stores and dwellings, where, by reason of its superior softness, steadiness and economy, the incandescent lamp must ever hold the ground as against all other methods.

THE HIGH RESISTANCE LAMP.

In analyzing the secrets of the success which has attended the work of the New York station, the initial experimental ground where to-day may be seen the demonstration on a grand scale of the hypotheses of less than seven years ago, we find undoubted advantages secured by the use of the principle of multiple arc distribution; we find also a wonderfully low resistance in dynamos, and in the bars of copper constituting the main conductors, but we also find that without which these other favorable conditions would be of little avail, a high resistance lamp.

Suppose we have a water motor so constructed that it

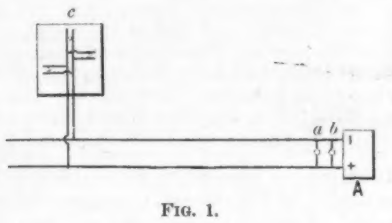


FIG. 1.

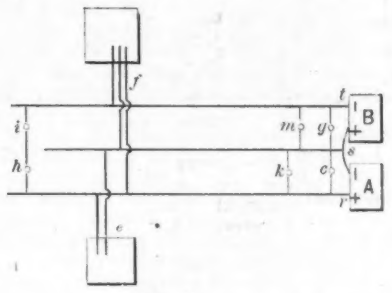


FIG. 2.

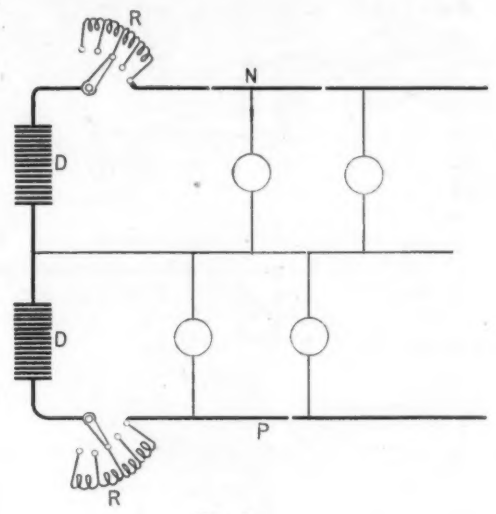


FIG. 3a.

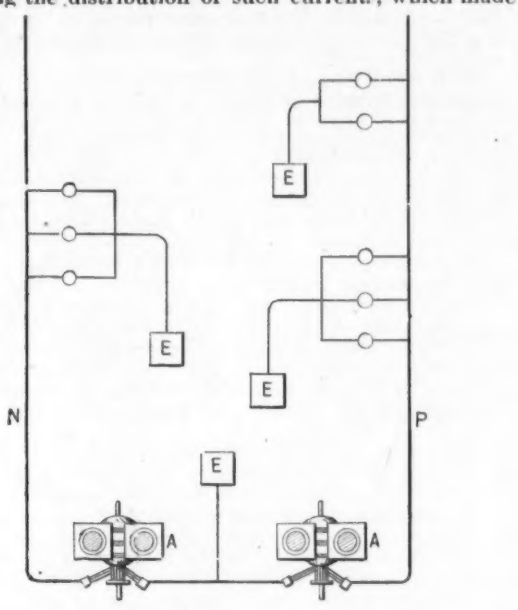


FIG. 4.

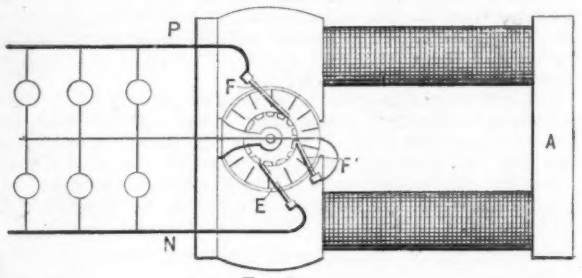


FIG. 3.

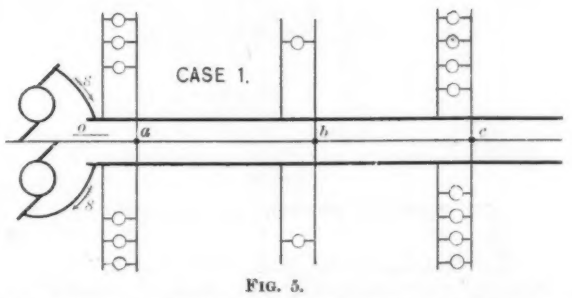


FIG. 5.

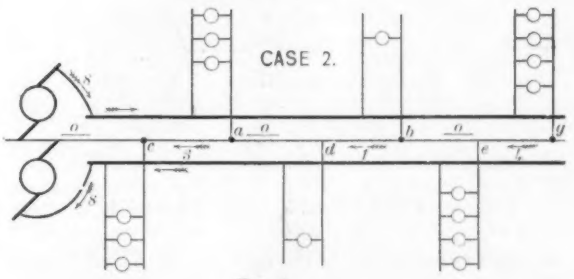


FIG. 6.

FIGS. 1, 2, 3, 3 a, 4, 5 AND 6.—JENKS ON METHODS OF THREE-WIRE DISTRIBUTION.

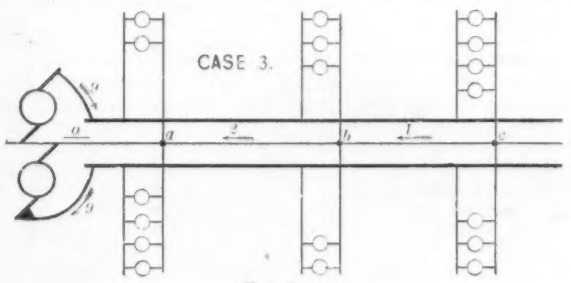


FIG. 7.

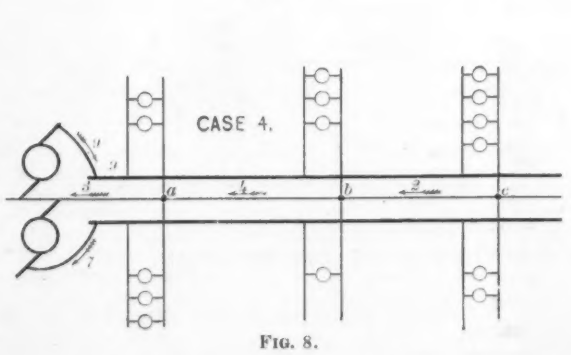


FIG. 8.

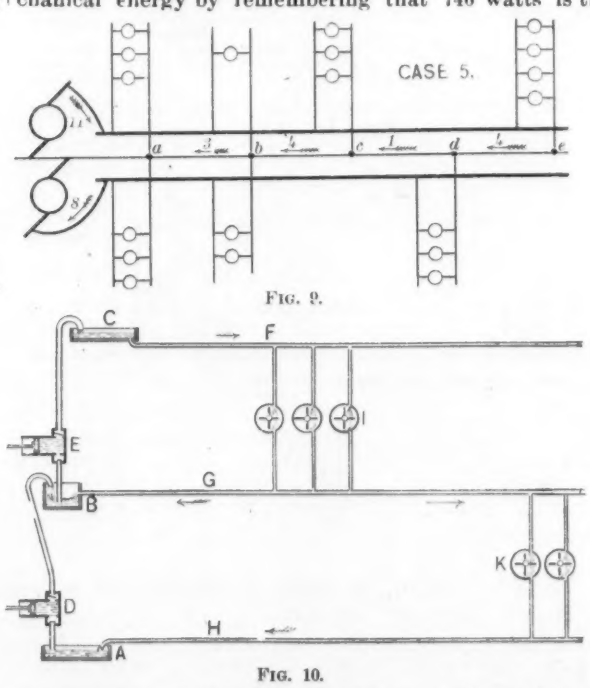


FIG. 9.

FIG. 10.

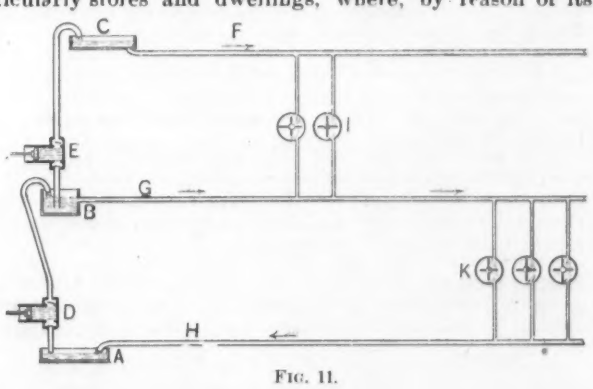


FIG. 11.

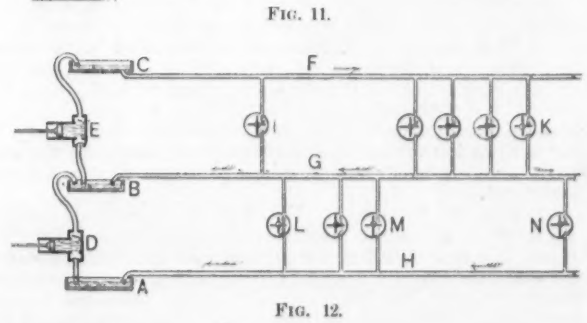


FIG. 12.

FIGS. 7, 8, 9, 10, 11 AND 12.—JENKS ON METHODS OF THREE-WIRE DISTRIBUTION.

delivers one h. p. of energy when using 10 gallons of water per minute. Suppose this quantity of water to be secured through a pipe of one-inch diameter, at a distance of 100 feet from the source of supply, by a pressure of 50 pounds at the reservoir or pump. If now we can so modify the motor that only five gallons of water per minute is necessary to do the same work, we shall find that to secure the passage of the five gallons through its mechanism the pressure must be raised to 100 pounds, and that as long as it is safe and economical to make use of this increased pressure we can carry the motor much farther away, and secure the same result at an additional cost for pipes less than the advantage gained in distribution.

So in incandescent lighting. Mr. Edison diminished the amount of current necessary to furnish a given light by raising the resistance of the carbons far beyond the point reached by other inventors. With less current to carry, less copper is required for a specified distance; and as, in addition, greater pressure is required at the dynamo, the same size of wire will carry current for a specified number of lamps at a greater distance.

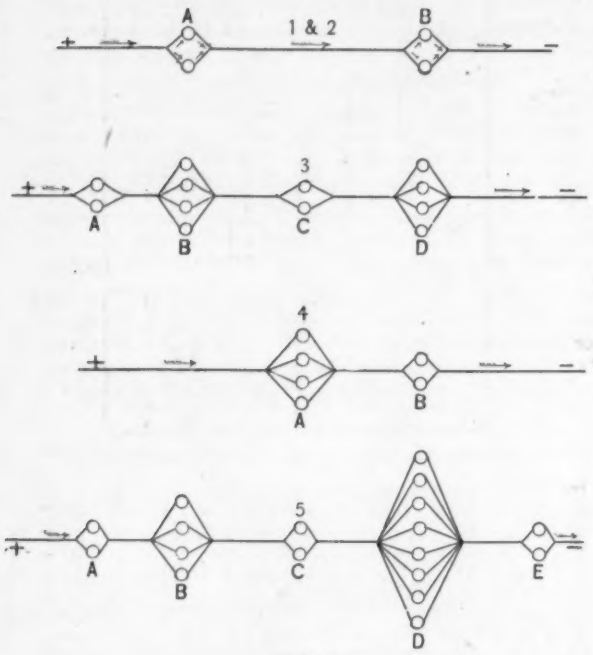


Fig. 13.

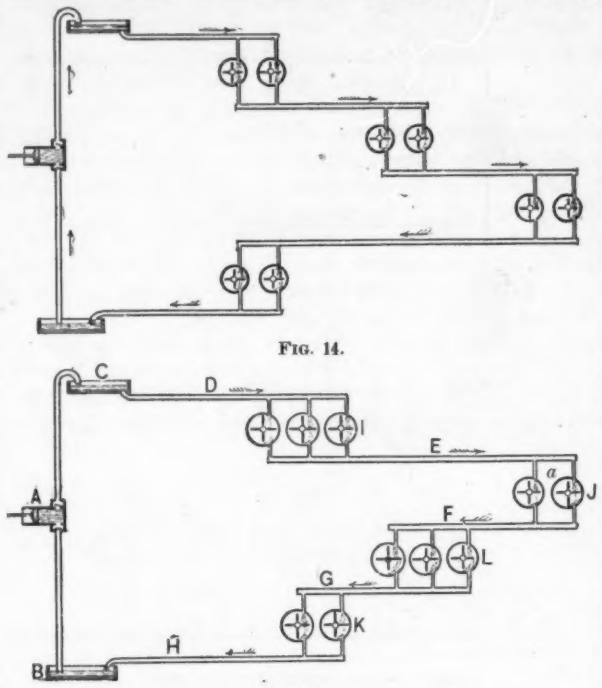


Fig. 15.

FIGS. 13, 14 AND 15.—JENKS ON METHODS OF THREE-WIRE DISTRIBUTION.

HIGHER PRESSURE—INCREASED ECONOMY.

But even this advantage did not suffice. The first New York installation showed too serious a first cost in conductors to serve as a type for general work of this kind, and when this became apparent to Mr. Edison the problem of introducing a higher pressure into the main channels of distribution was attacked with vigor, and a satisfactory solution secured in what is known as the Three-wire System, which has shown itself the lever which has lifted the business over the dead centre between failure and success. Here we couple two dynamos in series, thereby utilizing their combined E. M. F. and doubling the available current delivered over a given pair of wires at any point on the main conductors, while the attachment of a third wire to the link connecting the two makes it possible to use in any one lamp the force of only one generator and to make each lamp separately controllable. This peculiar arrangement and its contrast with the old two-wire principle is made plain by the illustration, Fig. 1. Here we recognize the familiar idea of two parallel conductors connected with the dynamo A, and at a and b lamps in multiple arc on the main wires and in any illuminated space, c.

Here we conceive of the outgoing current as traversing the positive main and all its conducting branches to the lamps, and returning, after doing its work, to the negative terminal of the dynamo. In such a system, of course, the greatest difference of potential to be considered is that existing at the brushes, which in central station work usually amounts to an E. M. F. of from 115 to 130 volts, according to the loss anticipated by the calculated resistance of the conductors and the resistance of the lamps to be used.

The Edison central stations, where the loss in distribution, when the system is taxed to its ultimate capacity, is from 10 to 15 per cent., are usually supplied with lamps requiring, in different cases, from 105 to 115 volts, and the economy of their use is thus made equal to that of isolated plants where the drop in potential from dynamo to lamp seldom exceeds 5 per cent., and where the lamps may be from 90 to 100 volts. It is now easy to illustrate the importance of a high resistance lamp and a low resistance armature.

Suppose the dynamo in Fig. 1 to be capable of feeding 1,000 16 c. p. lamps. Before connecting any lights we have, if our insulation be perfect, an infinite resistance between the conductors and (disregarding that of the field magnets), say, 0.01 ohm in the dynamo. Now connecting one lamp, 200 ohms, and throwing out the resistance of the conductors, we have $\frac{0.01}{200}$, or only $\frac{1}{20,000}$ the resistance of the whole circuit in the machine, leaving all but a minute fraction of the energy developed by the armature to be expended as useful work in the lamp. At this stage of the experiment the resistance of the lamp circuit is at its highest point.

Now turn on all of the 1,000 lights. Their joint resistance is 0.2 ohm, and so long as the coils of the armature remain cool the ratio will stand $\frac{0.01}{0.2}$, indicating that $\frac{1}{21}$ of the current is doing commercial work.

Having now arrived at the normal capacity of the generator, if the number of lamps be still further increased, a second dynamo must be connected in multiple with the first, so that the armatures may jointly give a sufficiently low internal resistance and the E. M. F. be kept up at the lamps. The method of doing this will be described further on.

Now transfer dynamo A to a new position, Fig. 2, and connect it in series with another of the same type B. Belting both to the same engine and running a third wire from any point on the conductor s between the two, we have the positive terminal of the combined system at r and the negative at t, with the middle wire alike negative to A and positive to B.

If the machines be run at their normal speed, the difference of potential between r and t will thus be, say, 200 volts, and between r and s, or s and t, 100 volts, or just the proper force for one lamp. If such a lamp, as at c, be connected, the A machine will be doing work, and the current will return through s to its negative terminal. If, instead, g be turned on, only B will produce current. In case both c and g burn at once, the effect will be exactly as if h and i (or k and m) were in use; the double E. M. F. then working through the double resistance to produce the same number of ampères as before, and the middle, or, as it is technically known, the "neutral" or "compensating" wire, practically cut. If the number of lamps on one side exceeds that on the other, a current will flow through the neutral to, or from, the machine carrying the heavier load, and by actuating the needle of an ampère indicator, will, by its direction, show the side most taxed and, by the angle of its deflection, serve as a measure of the difference between the two.

Now we are able to illuminate any buildings or spaces, e and f, by attaching their lamps to the A and B side of the circuit respectively; and supposing the distance of these points from the dynamos to be, for instance, one-half mile, we have sent the current over that interval at an E. M. F. double that employed in the two-wire plan. To secure the same loss with the same number of ampères, therefore, we need a wire of but half the cross section used before. But having doubled the pressure, we are actually using but one-half the current previously consumed to transmit the same total energy, and hence our two wires need weigh but one-quarter as much as those in the first installation. The addition of a third wire as an equalizer raises the outlay to three-eighths of the original.

To make this point more clear, notice that the joint resistance of a and b is, in the two-wire system, $\frac{200}{2} = 100$ ohms. With 100 volts pressure they absorb $\frac{100}{100} = 1$ ampère. Place the same lamps at c and g, and their joint resistance (in series) is 400 ohms. With 200 volts E. M. F. they, therefore, absorb $\frac{200}{400} = 0.5$ ampère, and this *one-half the original current*, which at the old pressure could be carried by a wire of one-half the size, being sent from the dynamo to the lamps at *twice that pressure*, can be supplied through four times the resistance, or one-quarter the mass of copper. Consequently one-quarter the weight of wires will supply the same number of watts of energy, and hence give the amount of light as before.

That this increased E. M. F. does not alter the energy expended at the dynamo is evident, for whether we consider the first case (100×1), or the second (200×0.5), we have the same result, 100 watts, about one-seventh of one electrical horse power for two lamps. Thus a vast saving is effected, not only in the weight of the expensive copper conductors, but in the size of the iron tubes, the amount of insulating material needed, the weight of the boxes which join the sections, the expense of laying in the streets, and the cost of subsequent repairs.

We are now prepared to look more closely into the somewhat complex action which takes place in the three-wire system. The fundamental patent, No. 274,290, was applied for Nov. 27, 1882, and issued March 20, 1883. Figs. 3 and 3a show the second of the patent drawings comprising (1) a single dynamo with three brushes, the middle one at a point half way in potential between the + and —, being connected with the ± conductor, and (2) two dynamos or other sources of energy with the ± joined in the usual way.

Fig. 4 illustrates a conception of grounding the compensating conductor at the station, and also making a ground at each group of lamps. Thus the current, having left the positive conductor of the system and vitalized one lamp, must make its way through two earth connections and the intervening mass before it can reach the corresponding lamp on the other side and the negative wire. One theoretical advantage here appears: The drop of potential between the lamps or groups of a series should, by this means, be reduced to nothing, and no loss ought to occur between any neutral plate and the source of energy in cases where the load was not perfectly balanced. Several practical disadvantages are realized. Among them are the extreme difficulty found, in actual engineering, of getting ground connections of no resistance and of maintaining such when a number of ampères must be carried. Hence a compensating metallic conductor has always been used, though recent experiments show that permanent grounds, distributed along the mains and connected with the compensating conductor, assist in keeping a desirable pressure by utilizing the carrying capacity of the earth, and probably protect the system from the effects of lightning.

The claims of this patent include: 1. One or more compensating conductors connecting lamp circuits with the source of energy; 2. A combination of two or more dynamos, feeders, lamps in multiple series, one or more compensating conductors connecting the lamp circuits with the dynamos at the points of division; an equalizer in each feeder.

ACTION OF THE NEUTRAL CONDUCTOR.

Several conditions must be supposed with reference to this third and intermediate conductor when the three-wire system is in operation.

In the first case, Fig. 5, the number of groups is the same on the two sides, the number of translating devices in each group being also the same. The opposite groups are connected to the same points on the intermediate conductor, which carries no current whatever.

In the second, Fig. 6, the number of groups remaining the same on the two sides, and the number of translating devices the same in each group, the opposite groups are connected to different points on the intermediate conductor. Those portions of its length between the points of connection y and e, b and d, a and c, carry a varying

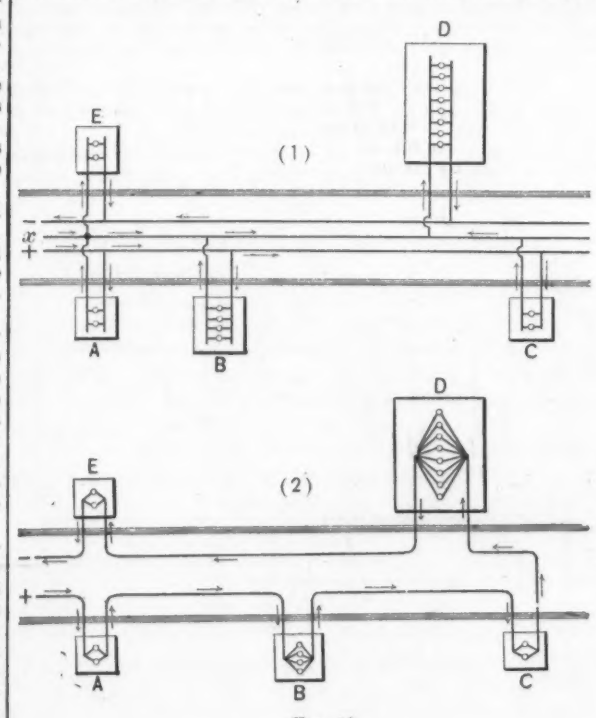


Fig. 16.

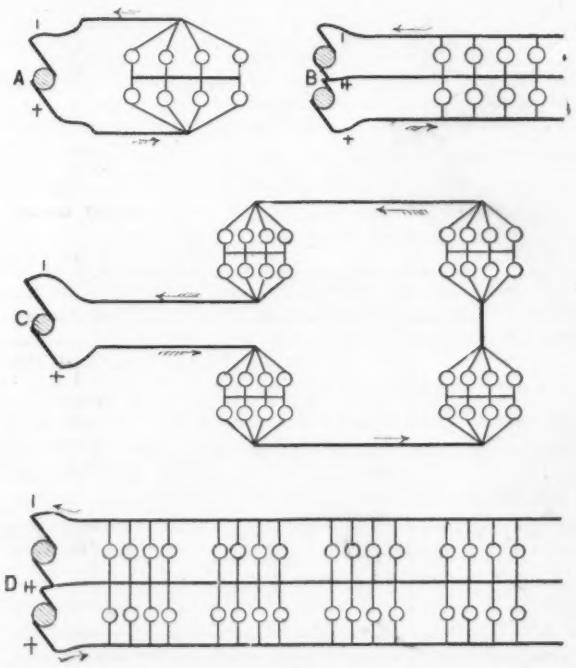


Fig. 17.

FIGS. 16 AND 17.—JENKS ON METHODS OF THREE-WIRE DISTRIBUTION.

number of ampères according to the number of groups represented.

In the third case, Fig. 7, the total number of translating devices remaining the same, and the whole number on one side being the same as that on the other, the number in opposite groups is different, these opposite groups being connected to the same point as the third conductor. From c to b this conductor will therefore carry the current for one lamp, and from b to a a second lamp in addition.

In the fourth case, Fig. 8, the number of translating devices in each group is different on the two sides, the opposite groups being connected on the same point of the intermediate conductor. Between c and b we find current for two lamps, between b and a for four lamps, and between a and the dynamos for two lamps.

And in the fifth case, Fig. 9, which represents very closely the actual working of the system in practice, we have a combination of all the conditions above given. In this case, the number of translating devices in each group and the number of groups are both different, and the opposite groups on the two sides are connected part to the same and part to different points of the third or intermediate

conductor. From *e* to *d* it conveys current for four lamps; from *d* to *c*, one lamp; from *c* to *b*, four lamps; from *b* to *a*, three lamps, and from *a* to the dynamos, three lamps.

Perhaps a still clearer conception of the subject may be obtained by illustrating graphically the analogy between electrical and hydraulic actions.

Let Fig. 10 represent a system of two pumps, one of which raises a body of water from a reservoir *A* to an elevation *B*, say 10 feet; the second taking it therefrom and lifting it an additional 10 feet to a third reservoir *C*. A conductor *F* conveys the water from this higher elevation to three wheels *I*, so arranged that portions of the water shall pass simultaneously through each wheel, all being

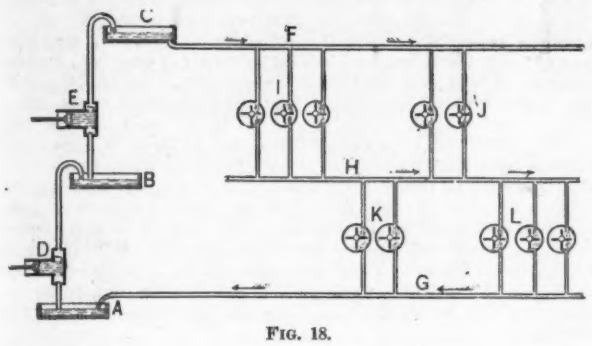


FIG. 18.

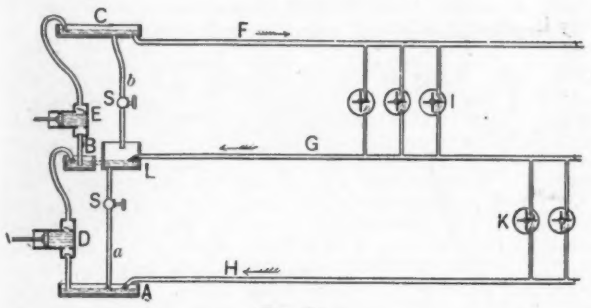


FIG. 19.

We may gain a better conception of this by another water analogue, Fig. 14. Here a single pump raises a body of water to a sufficient height to run a number of groups of wheels successively. We may suppose that a fall of 10 feet is required to operate each pair of wheels. The total elevation to which the water is lifted would, therefore, in this case be 40 feet, and each 10 feet of fall would represent a reduction in the pressure, or rather in the difference of pressure existing between the point under consideration and the level of the lowest reservoir to which the final discharge is made.

Groups of two wheels are so arranged as to correspond to groups of two lamps on a circuit using a constant current. Stopping the flow of water to any one of these wheels would either retard the entire flow, and thereby affect the working ability of others in the system, or would force a double quantity of water through the remaining wheel, thereby doubling the work done in a given time and endangering the wheel itself.

If now we arrange four groups of wheels, as in Fig. 15, the wheels being of the same size and capacity, the groups of three will run slow, or else the groups of two will run too fast, precisely as in the case of the combination of two and three lamp groups on a Brush circuit.

The contrast in the conditions of the workings of these two systems is still more noticeable when we consider the order in which they would be practically applied, Fig. 16. In the case of the Edison the group placed in each residence along a street is entirely independent of those in any other, and each lamp is independent of other lamps in the same group, the middle wire effecting a compensation between the different buildings connected with the system, and maintaining a uniform candle-

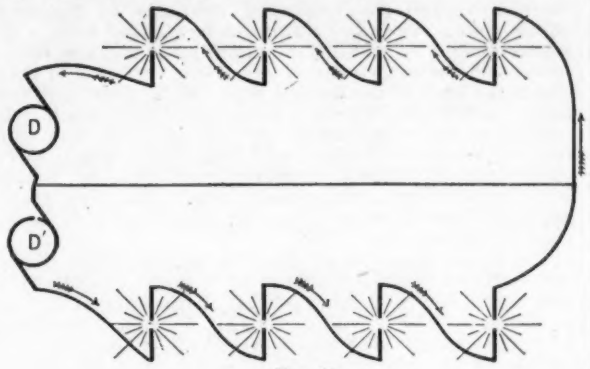


FIG. 20.

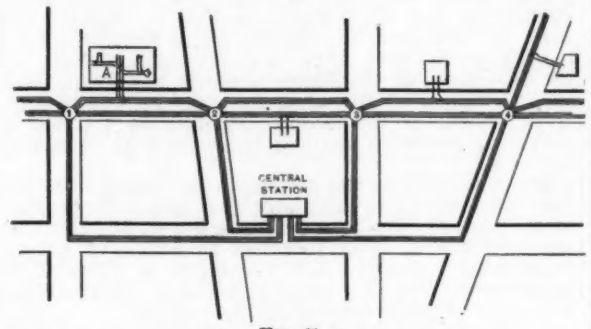


FIG. 21.

FIGS. 18, 19, 20 AND 21.—JENKS ON METHODS OF THREE-WIRE DISTRIBUTION.

operated by the energy due to the fall of 10 feet produced by the second pump.

Discharging into the pipe *G* a portion of the water finds its way through a second group of wheels *K* to the lowest level *H*, by which it returns to the original reservoir. If the group *K* represent 2 wheels, as in this diagram, the portion of the water which has already operated the third wheel in the group *I* will flow along the conductor *G* into the intermediate reservoir *B*, from which it is again lifted to the upper level and repeats the same action. If, on the contrary, the greater number of wheels are placed in the lower group, as in Fig. 11, the action is reversed, the lower pump *D* being called upon to do more work than the upper one, the amount of water necessary for the third wheel flowing outward from the reservoir *B* and returning to the lowest level without going at all to the upper reservoir, thereby effecting a saving in power.

In Fig. 12 we have a diagram illustrating more comprehensively the ordinary working of the electrical system in practice, two groups of unequal number of devices being attached on each side, and the action being to some extent complicated, calling into use the factor of intergroup compensation by means of a middle wire, as well as that of a balancing of the sides of the system by the outlet from the upper half into the middle reservoir.

PREVIOUS ARRANGEMENTS.

It sometimes serves a useful purpose in making clear the features of a system if we describe such methods as may have sufficient points of similarity to make it possible to confound them with the particular arrangement under discussion.

The Edison three-wire system has been sometimes confounded in its essential features with that of the Brush multiple series. This dividing, or subdividing, a constant current, so as to place incandescent lamps on an arc circuit, was probably first proposed by Werdermann, and was patented by Mr. Brush in this country quite early in the art. Fig. 13 shows several arrangements of incandescent lamps on a Brush circuit. Nos. 1 and 2 show the electrical division where an ordinary arc current of 10 ampères is divided between two incandescent lamps of equal power, and illustrates very clearly how the same current passes through two groups successively.

Against these on the diagram will be found two arrangements by which the same result may be effected on an Edison three-wire system. The contrast between the systems is brought out when we undertake to control lamps individually.

Suppose, for instance, in No. 5 of the diagram, we use lamps of the same candle-power and resistance throughout. In those lamps which are placed on the three-wire system we shall be able to turn any one out by the socket key without in any way affecting the brilliancy of the others, and at the same time we shall effect a saving of power, decreasing the current output of the dynamo by the exact number of ampères absorbed by this particular lamp. If, however, we undertake to do the same thing with one of the lamps on a Brush circuit we shall more or less seriously affect the candle-power and life of the others in the same group, unless in turning out we interpose a compensating resistance which absorbs the energy formerly used by the lamp, and consequently we are unable to effect economy in the running expense.

Suppose the lamps of these five groups to be of the same candle power and resistance. The amount of current which would bring the group *B* to a low red heat would raise either of the groups *A*, *C*, or *E* to a destructive white heat, and would barely warm the carbons of the group *D* which would thus become invisibly hot. This constancy of the current of an arc light circuit is, therefore, in a case of this kind an element of destruction if the number of lamps, or rather the resistance interposed by each group of lamps, is varied. Hence, there is no compensation in this system between these groups, and no compensation without the introduction of artificial resistance between the members of the same group.

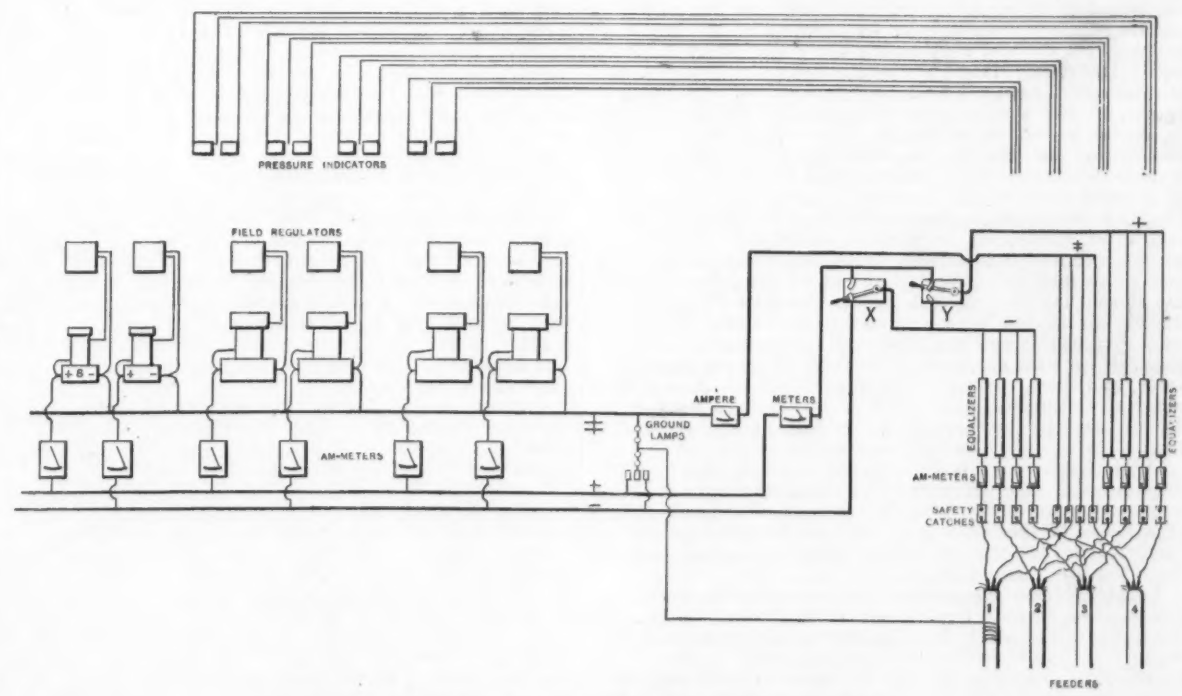


FIG. 22.—METHOD OF THREE-WIRE DISTRIBUTION.

have at *A* practically two groups of four lamps each, in series, on the Brush system. At *B* the same number of lamps are shown in multiple series on the Edison system. At *C* four times as many lamps are arranged in four clusters of two multiple series groups each, and at *D* the same number of lamps attached to the three-wire system, thus illustrating the effect of an extension in applying each principle. At *C* we have to maintain a constant current and increase the potential. At *D* we have to maintain a constant potential and increase the current, and we can also maintain an intergroup compensation and a total compensation for all changes in the circuit.

Mr. Brush evidently had the same idea as Mr. Edison, namely, a saving of wire and independent control, but the fact that his work had been restricted to a dynamo with a series field and an arc lamp naturally restricted his improvement to such an arrangement as could be applied to a constant current system of varying potential. So an entirely different result was obtained, namely, high potential, and only partial compensation. His patent, No. 261,477, claims: "A system for transmitting electric currents to translating devices, consisting essentially in an electrical conductor, divided along its length in two or more series of paths or branches, each path or branch of each series being electrically connected at opposite ends with the main conductor and translating devices interposed in said branch circuits, substantially as set forth."

It does not show any compensating conductor performing either of the functions of the Edison; it must receive a constant current in order to operate at all; there is no connection with the source of energy by a middle wire.

This feature of total compensation, as effecting the entire energy absorbed, is well illustrated by Fig. 18, which shows what would occur if the middle wire were carried back to and connected with the source of energy, the effect of turning on and off lamps being practically the same as in the Brush constant current system, the lamps an one side being raised or lowered in their candle power according to the changes made upon the other side.

A method by which the Westinghouse Company have recently (1887) undertaken to secure the same result is shown in Fig. 19. Here the water necessary to operate a given number of motors on each side is constantly raised to a given height, the compensating conductor being brought back to the source of energy, but not being connected in such a way between the two poles as to regulate the work done, the balance between the two being made good by the introduction of a choking valve, corresponding to electrical resistance, by which the flow of water in the compensating conductor can be varied in accordance with the varying conditions of the circuit outside. Thus, as in the practical operation of plants, there is always a greater or less difference between the load on the two sides of a system; in this method a certain amount of power is always wasted by being discharged, as it were, through useless resistance at the station.

It has often been stated that the methods of the three-wire system were anticipated in the plan adopted for the installation of United States plants in the Amoskeag Mill, at Manchester, N. H., and in the building of the Boston *Herald*. In each of these cases two arc light dynamos were placed in series, a number of lamps operated by each, and a wire from midway to the total circuit of lamps returned to a link between the two dynamos. This is shown in Fig. 20. It requires but a moment's thought, however, to discern the radical difference between the operation of such a method and that of the Edison three-wire system.

The arc light circuit depends for its normal operation, as well as safety, on a constant current. If, for example, one of the lamps shown in Fig. 20, as operated by dynamo *D'*, were to be turned out, an increased current would instantly be sent through the remaining three, the normal quantity continuing on through the second group of lamps and to the dynamo *D*, while the increase would make its way along the middle wire to the dynamo *D'*, thus stimulating its magnets and further increasing its output. Thus the middle wire in such a system would become, not a source of compensation, but of danger. In fact the entire motive for its temporary use in these two systems appears to have been the distrust naturally felt in the early history of the art with relation to the reliability of the machines themselves. Hence this middle wire was an "emergency" conductor, merely serving to keep in operation one-half of the system if the other half broke down. The best evidence of the fact that it was not only useless but dangerous is found in its abandonment by the company, as no other plant is on record as having been thus equipped.

With the further practice in the arc-light field these

power, and compensation with the station to increase or decrease the power delivered in proportion as the number of lamps is varied. In the case of the Brush system, which takes one wire up one side of the street and back on the other side, while it is possible, by varying the candle-power or the resistance of the lamps, to use up a current say of 10 ampères in two 5-ampère lamps, four 2½-ampére lamps, or eight 1¼-ampère lamps, yet these individual lamps are not, in the strict sense, separately controllable, and practically all the variation that can be made in the number of lamps in circuit is made by turning off or on one entire group. This has the effect of decreasing or increasing the pressure at the dynamo, the current flow through the entire system remaining constant, and traversing the different groups of lamps *successively* instead of *simultaneously*, as in the Edison system.

Fig. 17 represents the closest approach to an apparent parallel on paper which can be diagramatically made. We

original ten-light machines were supplemented by others of larger capacity, and greater faith in the reliability of the apparatus caused constructors to omit any such "emergency" wire as being not only a source of possible danger to the system, but a useless outlay in copper.

A SUMMARY OF ADVANTAGES.

The Edison three-wire system presents, therefore, several points of special interest which may be briefly summed up under four heads:

1. A compensation at the source of energy for the difference between the total output of one side and that of the other.

2. An intergroup compensation between the different clusters of lamps in the same main, or in adjoining buildings.

3. The retention of the old multiple arrangement by which the individual control of lamps is secured, coupled with the reduction of the expense of conductors to three-eighths of the previous amount.

4. The result of all these favorable conditions making comprehensive systems possible with a reasonable expenditure of copper in conductors and rendering it easy to make such systems profitable, as the record of a large number of stations has for years demonstrated.

The extent of reduction to which Mr. Edison has thus carried the three-wire system has sometimes been criticised on the ground that it is not in harmony with the principle established by Sir William Thomson and others, viz., that the 'additional running expense due to the resistance of the conductor shall equal the interest on its first cost." While this principle undoubtedly applies, in the light of present experience, to arc circuits where the load is practically constant, it cannot be economically enforced in all, or in perhaps in a majority of cases, where, as in a central station incandescent plant, the percentage of heat waste varies from hour to hour, attaining a maximum during an hour or two each week, and cannot be computed in advance for any given system, as an average can only be arrived at as the result of actual observation, and the point of greatest economy for one system cannot be quoted as a guide for another, in which the hours of lighting may differ widely. In point of fact it has thus far been found desirable to vary the percentages of maximum loss in feeders and mains of different systems, according to local circumstances, chief among these being the cost of producing power.

DISTRIBUTION BY FEEDERS AND MAINS.

One of the most interesting features of the Edison system is the method of carrying out this idea in distributing the current through the streets of a city. This may, of course, be done either by underground conductors or pole lines, though in large places the size and number of wires, and the fact that the poles should not be more than 100 feet apart, makes the inconvenience almost equivalent to a prohibition. Where an underground system is impracticable on account of scattered buildings, as in many residence districts, it is often advisable to erect poles along private ways or alleys, or even between these, on the rear lines of estates, where they will prove least objectionable. If thoroughly constructed of the best material, overhead lines offer many advantages in some localities, and cost originally only about one-quarter as much as a tube system.

To illustrate the principal features of either plan, let Fig. 21 represent an underground installation in one street, with the station as near as possible to the centre of consumption of light. A main is laid on each side of the street, about two or three feet from the curbing, and connected at convenient intervals, usually at the intersection of crossing avenues, with junction boxes, which are in practice buried near one corner of the sidewalk nearest the station, very much after the manner of the street hydrant. Each main contains three wires, and the positives, neutrals and negatives of all the different mains of the system are connected at the boxes each to each, as if in a single line. Feeders are now run from the station to the junction boxes, their several resistances so calculated that the greatest supply of current shall be near the point of greatest consumption. Properly constructed, the insulation of an entire system of this kind should be very high, sometimes reaching in actual practice to hundreds of thousands of ohms. Service tubes may be connected at any of the joints between the 20-foot lengths, as at *A*. Here the size of the building to be lighted makes it advisable to carry the three-wire system through the edifice, dividing perhaps on each floor, or for each main department. In the cases of theatres, churches, rinks and other public places this plan is especially desirable, as the size of inside wire may be reduced, and by intergroup compensation the important feature of a perfect balance on each main is assured.

The three-wire plan as thus far elaborated, illustrates very forcibly the advantage of a system connected as a single network of conductors over that of radiating lines. If a main be broken at any point so that the supply of current from the nearest feeder is cut off, it is still charged from the other direction.

As Mr. Edison has graphically expressed it, "the current comes around the corner from the next block, and the lights still burn." If a feeder be disabled from any cause, the fusible strips are removed at the station, those by which it is connected with the system at the catch-box on the street are taken out, and it can be readily repaired while the remaining feeders supply the mains. The lamps illuminating the central station are taken from the mains instead of directly from the bus bars, that their action may be noted by the operator in charge, as an indication of the working of those outside; and, also, because with any considerable load the drop in potential between the station and the lamps on the street, occurring in consequence of the resistance of feeders and mains, obliges the maintaining of a comparatively high E. M. F. at the dynamos which would speedily destroy lamps of the resistance—or, as technically known, of the "volt"—used by consumers.

Right here we encounter one of the cardinal difficulties of distribution for incandescent work—that of equalizing through the system the drop in potential occurring whenever its full capacity is approached. To secure practically perfect results, the resistance of all the feeders and mains must be so proportioned and regulated that, however the resistance of any point or section of the lamp circuit may vary, the current shall maintain a nearly uniform pressure in all the ramifications of mains and inside wiring of buildings, and each lamp give the same light as every other. An exact regulation is practically impossible, but we may far exceed the best results in water or gas pressure in our approach to the ideal condition. It is only necessary in addition to a proper calculation of the resistance of each of the several feeders, in their construction, to slightly vary their conductivity from time to time by means of resistance boxes known as "equalizers," introduced into their circuits at the station.

Now, if in consequence of a large consumption of light in the neighborhood of *A*, Fig. 21, the pressure drops at boxes 1 and 2, a little resistance on feeders 3 and 4 enables us to raise the pressure at the station and send sufficient current through the weakened channels to restore the equilibrium. The same result can be secured with a saving in current by making the mains large and the drop in feeders of less consequence. That this variation of potential at the ends of the feeders may be known and regulated, each feeder tube is supplied with three small wires connected with the system at the junction box which forms the feeder terminus, and acting as a return circuit to the station, where a voltmeter or indicator of peculiar construction is attached on each side. This arrangement appears in the diagram, Fig. 22, illustrative of central station connections.

The feeder principle of distribution, by which the central station is scattered about, as it were, to all the junction boxes, and from these points delivers current of proper pressure, is entirely original with Mr. Edison. The methods of the gas companies, which were closely followed so far as they were adaptable to the government of the more potent agent which we utilize, did not at the time of application for the feeder patents (No. 264,642, issued Sept. 19, 1882, and No. 266,793, issued Oct. 31, 1882), include any analogous means of equalizing pressures. Since the experience of the Edison stations has demonstrated the usefulness of the idea, gas engineers have applied it to several of the most comprehensive systems now operated, and with marked improvement, as might be expected.

By these methods and devices, in connection with mains, and house wiring so calculated as to avoid the heating of small wires by attaching too many lamps, and raising the candle-power in other localities by reason of excessive conducting capacity, the regulation is effected with such nicety that there is no perceptible difference in the brilliancy of lamps throughout the system.

A little reflection will show the fallacy of the effort so often made in central station work to establish an automatic regulation of pressures by compound wound dynamos. We can attain to such a perfection of manufacture as to make a dynamo which can be guaranteed to give a potential varying at the brushes to a sufficient degree to make up for the loss in a feeder line; but we are still powerless to compensate by that means for a greater loss in one feeder than in another. Hence, in systems of any magnitude, and practically in all systems supplied by more than one feeder, it has been found essential not only in the interests of simplicity but of reliability, to depend upon hand regulation and the careful oversight of intelligent inspection.

DYNAMOS IN MULTIPLE ARC.

Perhaps there is no one point more forcibly illustrative of the adaptability of the Edison methods to the constantly varying requirements of central station work than the readiness with which the dynamos may be connected to work together, like spans of draught animals, each adding its measure of efficiency to the power of the others to produce a common result. As early as 1883, at the Louisville Exposition, sixteen 450-light machines were so arranged, and in the first New York station the six mammoth dynamos, capable of carrying 2,000 10-candle lamps each, have been since 1882 manipulated in precisely similar manner, the only care needed being to keep their E. M. F. equal, that the load may be well divided, and that no opportunity may be given those yielding normal current, to short-circuit by over-balancing the reduced force of any other, and pouring their current through its armature. In practice this is perfectly easy. The exact conditions in the case of the three-wire arrangement may be understood by Fig. 22, which also shows the general method of connecting the generators with the regulating mechanism and the feeder system. Here are shown two dynamos of small size belted preferably direct to the two driving wheels of a high speed engine. This pair of machines is very valuable in a small station, inasmuch as the early evening and late night work may be done with much greater steam economy than by the heavier dynamos. The field regulator connections will be perfectly understood from this view.

Any dynamo in the system may be so connected at a moment's notice as to take the place of any other, as in practice a spare engine is always kept "warmed up," its piston barely moving, ready to speed without delay.

The process of switching so as to avoid flickering and flashing of the lamps on the circuit was, in the early history of the business, a somewhat complicated one. The ruling spirit of the station took his place at the regulators, his assistant at a group of switches controlling the dynamos. If the load was on the increase, and to be thrown from the small to a large pair of machines, the latter were brought to speed, and as he turned out the resistance from their field circuits, the electrician watched the dynamo pilot lamps until those on the heavy pair arrived at the proper comparative brilliancy. A nod to the assistant, and the proper switches controlling the larger dynamos were thrown in, and both pairs of generators were working in unison. Carefully turning out resistance in the fields of the incoming dynamos, and at the same time weakening those to be relieved, the load was quickly shifted, and at another signal the switches of the small dynamos were opened, the full resistance thrown into the circuit of their field coils, their magnets almost instantly lost all their power, and the engine was stopped at leisure. Later apparatus furnishes individual ampèremeters and comparative voltmeters, by which these changes are very rapidly made without any flickering whatever.

OTHER STATION DETAILS.

The neutral wire is usually designated by the character ±, a combination of the positive and negative signs.

Just outside the ampèremeters on the positive and neutral omnibus wires (corresponding to the holder in a gas system so far as to be the centre from which distribution is effected), are two heavy switches, *X* and *Y*, by which the positive or negative of a small station carrying a light load may be cut at will. Suppose that while carrying only a medium number of lamps, dynamo No. 3 suddenly gives out. Throwing the lever of switch *Y* downward, the circuit of the useless machine is instantly opened, and with barely a flicker the load is saddled upon its companion which now supplies both sides of the circuit, the neutral wire becoming positive to both the others. In such a case, which is very unusual but possible, the E. M. F. is reduced to 110 volts, and the number of lamps which can be kept at candle power depends upon the carrying capacity of the middle wire of the system, which must supply all the current used. Under these conditions, it is interesting to notice that two lamps connected in series, between the positive and negative, would go out, or motors so connected would stop, these outside wires now being of the same polarity. The "omnibus" wires here divide, and the positives and negatives of the individual feeders pass through the equalizers, and also heavy plug switches and the station safety catches, and by flexible cables join the feeder conductors. The small pressure wires issuing from the tubes are connected with those above the omnibus wires, and lead to the volt indicators.

The presence of a ground on the system is instantly shown by a group of four lamps permanently connected to earth and to the middle wire, and so adjusted by a plug switch as to be readily attached to either positive or negative in the manner indicated. The phases of their operation are very difficult to describe, but will be understood by an electrician. They give something like twenty-five different indications, and are very valuable as a tell-tale, showing any variations in the practical insulation of the system.

WIRING OF BUILDINGS.

The matter of wiring buildings for the three-wire system has been a subject of special study by the Edison Company. Early in the business any installation of fifty lights or less was attached to one side alone, overlooking the fact that in traversing the neutral wire for a considerable distance to another building a drop occurred, which was likely to materially decrease the candle-power of both groups of lamps fed by a given number of ampères. Now in the best practice we divide the lamps of a group of six or more in any one building between the two sides, and secure a close approach to perfect distribution, the effect being not only to reach an accurate *total* balance, but an accurate *local* division on each main. Hence wiring adapted to be connected to a three-wire service is essential where a connection with an Edison system is expected.

Speaking of wiring, and that twin idea which to a practical man is immediately suggested, namely, inspection, I trust I may be pardoned if I quote a paragraph from a paper which I read before the Society of Arts in Boston early in 1885, which has proved prophetic, and is unfortunately as true to-day as it was when first read, more than four years ago:

"The important matter of careful inspection of incandescent light apparatus and wiring does not seem to have heretofore received at the hands of the insurance officials the attention it deserves.

"The gravest aspect of the case lies in the fact that, as the incandescent system gains popularity and its great advantages become really appreciated, new business blocks, public edifices, fine residences, in fact, multitudes of structures will be wired during construction, and the work, good, bad or indifferent, rapidly covered, preventing adequate inspection, except as the result of persistent and painstaking scrutiny.

"With the growth of the general industry new firms and individuals will enter the field as wiring agents, and many who have done electric bell, speaking tube, burglar alarm, and kindred work will fancy or assume that with the cheap material or labor upon which numbers of them rely as their principal stock in trade, and some smatterings of book-lore as to harmless battery currents, they are abundantly equipped for business without the special experience regarding insulation, computing size of conductors and the proper distribution of light which are recognized to be indispensible to safe and successful wiring. One of two things will then happen; the public will be disappointed, whenever such people are employed, in finding themselves unable to use the wires and fixtures for which they have paid, or stand in imminent danger of having their edifices burn over their heads. This is not an imaginary picture. Some of the Boston inspectors know that instances already exist, almost within a stone's throw of this spot, where such wiring has been done by inexperienced parties, whose misrepresentations have victimized those who have employed them, though perhaps in many instances the truth has not yet appeared. In some cases, however, the attention of the underwriters has been called to the matter in time to apply the remedy without the great inconvenience or expense of tearing up carpets, cutting floors, and defacing ornamented walls and ceilings. The moral is obvious."

RELIABILITY OF THE DYNAMO.

The Edison dynamo, powerful as it is for the production of currents of tremendous heating energy, contains within itself the elements of safety in extreme cases. If the main conductors come by any chance into metallic contact, or are suddenly connected by carbonized material of high conductivity, the external resistance is so quickly reduced that before either a destructive arcing can take place or the armature itself become seriously heated, the curent will forsake the circuit of the field magnets, and their strength will instantly fall below the power to generate further dangerous force. It is a fact, therefore, that the large Edison machines, and perhaps all sizes of the latest construction, are of such low resistance as to be practically indestructible by short-circuiting, except by an accident when running in multiple arc with others. Even then a suitable safety catch will melt and prevent damage.

CONSERVATION OF ENERGY.

In this system, successful because commercially applicable to the needs of society, we may find a beautiful illustration of that most sublime of scientific facts, the imperishability of energy, and also of that other interesting and vital principle, the ready transformation of Nature's forces from one form to another. We may note here successive examples of the losses attending every change, leading us up to that crowning conclusion, the unity of all these forces or manifestations as a single, all-pervading, all-controlling energy called into being by an Omnipotent Author, by means of which He has brought order and beauty from chaos, and responsive to which every atom of the universe (boundless to our fettered sensibilities) quivers and vibrates and oscillates in perpetual obedience.

You enjoy in your library the incandescent lamp, the rays of which are concentrated without perceptible heat upon your paper as you write or read. Did you ever stop to inquire how many transformations of energy were necessary to furnish that light for your convenience, or what losses were incurred in these changes?

Thousands, perhaps millions, of years ago, before man's appreciative intelligence was evolved through the wonder-working of the Creator's slow but sure design, a mass of matter wandering through the infinity of space, was attracted by the gravity of our central sun. As it plunged into his fiery atmosphere the energy of the motion into which the force of gravity was transformed, was converted into heat, and additional energy in the form of chemical action as the mass burned intensified this heat and transformed it into light which sped to our little world, fell upon forests of marvelous luxuriance, changed in a twinkling again to chemical affinity and was stored away in the wood, changed as the ages rolled by to coal. Here it lay idle and inert until now in the fulness of time man digs it up and throws it under the boiler. Again the wonderful attraction for oxygen, so long latent, instantly asserts itself. It flashes into flame, its energy rapidly changes to heat, then to expansive force of steam, then to motion in the cylinder, belt and armature, then to magnetism and to its twin sister electricity, flies along the conductor, and in a trice its desperate effort to pass the delicate bridge of the carbon filament is arrested and its impetus is transformed into heat and light once more.

Thus far we can follow the losses we have sustained in our effort to use Nature's stored energy. We are, at best, able to save in the steam produced about 70 per cent. of the heat units which were originally laid away in the coal which we to-day place upon the grates. Allowing that 16 per cent. of this steam energy is lost in condensation and friction in the pipes, we encounter in the engine the enormous loss of 83 per cent. of the remainder, and hence we find delivered to the dynamos by the belt only 10 per cent. of the original power. This dynamo, as a marvelous transformer of one form of energy to another, stands alone. In our central station work we expect, after allowing for all the losses by friction, resistance of armature conductors, Foucault currents in the core, and the portion expended in vitalizing the field and in its regulator resistance, the retardation of the air and other hindrances, to get back about 93 per cent. of the energy with which we feed it. Hence we probably realize in electricity 9.3, or less than 10 per cent. of the heat units in the coal. Then we lose, say 10 per cent. more in conductors, and lastly we find the incandescent lamp can convert for us into light only about 5 per cent. of the watts brought to its terminals, including, of course, the loss in the best pot glass bulbs. The effect produced in a room by an ordinary 16 c. p. lamp, therefore, represents in actual energy radiated as light about 0.18 foot-pound per second, or a power sufficient to lift one fifth of a pound one foot high (against the force of gravity) in one second. It has taken, however, an expenditure of 200 times this energy, or 40 foot pounds per second in heat units at the coal pile to make this result possible. What interests the central station manager is that his receipts are only reckoned on the one-fifth of a foot-pound.

But another series of marvelous transformations remain. The light falls upon our paper and is reflected to the eye. Traversing the crystalline structure it strikes upon the sensitive retina, is metamorphosed into heat, then nervous force (perhaps electricity), and speeding along the conductors which are the telegraph lines to the seat of life, the impulses of this delicate current disturb the sensitive matter of the brain, and by the arrested motion or heat of their impact convey to the ever watchful operator, the soul, the messages coming from the material world outside.

Have you ever thought that this coal is the greatest of the storage batteries from which we can draw the little supply we borrow from Nature's vast laboratory? We try to imitate the operation of the elements in treasuring up force only to find how meagre our powers are.

It is only when we can reduce the first cost of the power we expend by taking advantage of this perpetual storage by Nature that we can afford to supply ourselves with an apparatus necessary to bridge over any temporary failure, either of the supply of water, transforming or distributing machinery. If we attempt to avoid the necessity of a constant action of our dynamos by a system of accumulators, we complicate an expensive process still further by introducing two more chemical transformations, and so reducing by from 20 to 50 per cent., according to circumstances, the electrical energy furnished by our generators, and are compelled to buy expensive apparatus, expensive not only because of its first cost, but its invariable, and often rapid, depreciation. Thus, as over vast stretches of the earth's surface water powers are entirely lacking and wind-mills cannot be depended upon, until Mr. Edison's dream of the economical production of electric light currents directly from coal can be realized, we are restricted in the uses to which we can apply stored electricity. These uses, however, much restricted though they may be, are often of the first importance, and the actions which take place are among the most interesting which we meet in the whole practice of electrical science.

The action of the current on the battery plates tears apart or dissociates the chemical elements, which are then held at arm's length by the energy poured through them, or the stress produced by the passage of the current, but which ever tend to recombine as quickly as the removal of the disruptive energy, or the closing of a circuit forms a path for the flow of the electric current into which the chemical affinity is retransformed. Even in our most successful efforts we find it uneconomical to use batteries for incandescent lighting, for the running of street cars, or for other purposes, to store more than a quantity to run our lamps for an evening of five or six hours, or our railway motors for more than a part of a day's work. The Edison Company has now for the first time ordered accumulators for a small station, and proposes to test their practical value in enabling it to supply light and power from midnight till morning. The gas companies are similarly unable, in transforming the latent heat units of the coal into the invisible fluid by which they distribute light, to store more than a limited supply day by day. The accumulators of the hydraulic engineer do not store even one hour's supply, and compressed air receivers have about the same capacity.

The most feasible method yet found for storing mechanical power on a large scale is by the reservoir of water. How large this must be, few of us have probably reflected. If you allow to a turbine wheel an efficiency of 75 per cent. it will require one acre of water one foot deep to supply even one horse-power for one hour for one foot of fall. Thus it has been through ignorance of the real facts that many people have lifted up their voice against the methods which we are compelled to pursue in generating electricity only as fast as we can use it for all the manifold necessities and conveniences of modern society. It has been forgotten that we have no means of putting into stock any form of force, and that, practically, energy must be produced as it is wanted.

Again, we have not learned to absolutely control such storage cells as we can produce, and we are daily learning the terrible hazard of confined forces, whether naturally or artificially massed. In man's toying with the electric spark one of the first things was the transformation of the energy of motion into frictional heat and electrical stress. The Leyden jar stores this volatile energy for a short time—then expends in a thousandth or a millionth of a second what has been minutes in accumulating. In other words, the rate of doing work is so greatly accelerated in the discharge that there comes a time when no matter what the medium through which the difference of pressure is equalized, it is not able in its normal condition to transmit the flow rapidly enough, and is disrupted or broken through.

We find that this swift, potent and flexible agent, in its milder, or we may say slower, manifestations, shows no signs of a troublesome inertia, even when we force it to turn sharp corners so quickly that thought fails to follow it. But if we attempt to force a vast energy through even a good conductor in an infinitely short time the material itself shows its inertia by blocking the path of the discharge and causing it to fly aside. This points to the idea that our measurements of electrical pressure are really measurements of electrical *velocities*, and that for all the purposes of our practical work, and so far as we know, absolutely, the speed with which electric action takes place is measured by what we call its potential, or power to do work, with the pressure which is the resultant.

So the silent power of the sunlight expended as heat on vast bodies of water raises a percentage of their mass to vast heights, and sudden condensation changes the energy thus stored to electricity. The accumulated charge is confined by the suspended moisture above a stratum of insulating air at the surface until its potential, far above anything man's puny apparatus can produce, bursts the bonds of the air, and in a fraction of a second the imprisoned might accumulated during many hours is expended upon the forest tree. Its resistance impedes the rushing thunderbolt, and the energy of arrested motion is transformed to heat, turning to superheated steam every drop of sap in an interval of time so small that the human mind cannot measure it, bursting every moisture channel as if filled with dynamite, and scattering the toughest tree in splinters on every side. Here is energy expended in a contracted area at the rate of millions of foot-pounds per minute.

FIGS. 1, 2 AND 3.—NEW MCINTIRE TERMINALS.

We build high walls to store the energy of falling water in reservoirs. For days and weeks and months the potent forces of the sky quietly raise it from the rivers, the lakes and the ocean, and deposit it gently in our frail storage vessel. There we hold it against the force of gravity, its depths as tranquil as the mountain side which is reflected on its bosom, until our feeble barrier crumbles and suddenly breaks, and all the energy which has slowly and silently accumulated is expended in a single hour, with a crash like that of rending worlds before the fabled blast of indignation from an offended Deity, destroying in its resistless rush the cities, the homes and the lives of men.

It is unscientific as well as foolish and irreverent to preach of judgments upon us and mysterious dispensations of Providence in cases like this. We are but learning how to bring to our service more completely the grand forces of the earth and sea and air, though sometimes our shortsightedness brings us suffering and dismay and loss ere we grasp the lesson.

Perhaps no thought can be more profitably emphasized and carried away with us than this underlying principle of all our work. No energy is ever destroyed. It is depleted by transformations, but the portion which we fail to recover has simply changed its form and been distributed or dissipated beyond our reach as heat.

Let us point one of the great telescopes of our observatories toward a spot in the midnight heavens, which to our natural vision is a blank. Its giant eye gathers in and localizes rays too faint for unaided human sight to catch, and we are in effect transported in an instant hundreds of millions of miles. Far away in the regions of immensity, deeply sunk in the depths of space, we dimly discern a light, hazy cloud. Apply a higher power and this cloud brightens and separates into distinct stars. The ray of light which sparkles upon the retina of our eye left that glittering sun before the dawn of human history.

During the dim ages of the past it rushed on at the rate of more than 17,000,000,000 miles every day through the shadows of infinite space. The Sphynx and the pyramids have been reared from the sands of the Nile long since its flight was well begun. Nations have risen, flourished, died, but it has stopped not, it has loitered not, it has shot onward in its terrific speed, and when it has finished its journey, its energy, lessened by what we call the losses in dissipation through the limitless areas of the heavens, is expended upon our sensitive photographic plate, instantly transformed into chemical action, and we have a fadeless image of the source from whence it came.

The McIntire Terminals.

Our readers will recall the connectors for all kinds of electric circuits made by Messrs. McIntire & Co., of Newark, N. J., and consisting of two brass tubes brazed together, into which the wires to be connected are inserted and then twisted into intimate contact without soldering. These connectors are now in general use, and the same firm has for some time past been extending its line of products in this direction by devoting attention to the terminals employed in various electrical apparatus, such as lamps, dynamos, motors, switch-boards, etc. The accompanying engravings show different forms of these terminals, whose employment not only insures a good contact but avoids the frequent breaking of wires when they are bent around the contact screw, as is usually the case. A "protector" is also provided in connection with these terminals, which covers the insulation of the wire for some distance from the terminal and prevents its unraveling, as is frequently the case under ordinary conditions of operation. We may add that Messrs McIntire & Co. have just been awarded the John Scott Medal of the Franklin Institute for the high character of their products.

Reorganizing the Westinghouse Company.

With regard to the plans for consolidating the Westinghouse electrical interests, the following special dispatch from Pittsburgh of July 11 gives the latest details: "The stockholders of the Westinghouse Electric Company at a meeting to-day decided to reorganize under the name and charter of the Westinghouse Electric and Manufacturing Company. In order to do this Mr. George Westinghouse secured, by purchase of a majority of the stock, the charter of the Chartiers Improvement Company, an instrument granted by legislative enactment in 1871, which conferred upon the corporation named extraordinary powers and privileges, such as have been impossible to secure under instruments of the same class granted by the State since the new Constitution of Pennsylvania went into effect in 1874. The name of the Chartiers Company was changed last month. The charter is of the old-fashioned blanket order, empowering those operating under it to do any sort of business or manufacturing, with the exception of running a bank and issuing bank notes.

"All the electric companies now controlled by the Westinghouse Company will be consolidated as soon as possible and their field of operations extended, the last obstacle having been removed by to-day's action. The company is now doing a business of $12,000 daily and employing 2,000 men. The certificates of the old company are to be exchanged for the new, share for share."

Is Electrical Execution a Cruel and Unusual Form of Punishment?

The feelings of the condemned criminal as he is expected to sit, bound and helpless in the fatal electrical chair, may have been experienced to a considerable extent by Mr. Harold P. Brown, as he passed through the ordeal of a cross-examination by Lawyer W. Bourke Cockran in New York on Monday, Tuesday and Wednesday of last week. On Monday morning Referee Tracy C. Becker, of Buffalo, began taking testimony in the case of Wm. Kemmler, a convicted murderer who was condemned to die June 24. Suit has been brought against Charles H. Durston, warden of Auburn prison, to prevent the infliction of the death penalty by electricity, on the ground that the punishment is "cruel and unusual," and therefore prohibited by the State constitution. Kemmler's counsel, C. S. Hatch, of Buffalo, is associated with Lawyer Cockran.

When the lawyers and experts assembled at Mr. Cockran's office on Monday, that gentleman opened by saying that he did not think that there was much use in taking testimony as to facts. Certain facts regarding the operations of electricity were well understood. He admitted that men had been killed by electricity, and he did not propose to contradict that.

Deputy Atty. General Poste thought thequestion to be determined was whether killing by electricity was a cruel mode of death, and this it was proposed to settle by testimony.

It having been agreed to call the members of the State Commission and make their evidence the basis of the investigation, a telegram was sent to Elbridge T. Gerry, the Chairman, then at Newport, R. I. asking him to be present. He telegraphed that he could not appear, and he is no doubt excusable for preferring life on his yacht to such an ordeal as he is likely to encounter at the hands of Mr. Cockran.

At the suggestion of Mr. Cockran, Harold P. Brown was sworn at once and taken in hand by the great lawyer.

The usual preliminary biographical questions were asked, to which Mr. Brown replied that he had been in the electrical business for 13 years, beginning in Chicago as agent for Edison's electrical firm. He then took charge of the business of Geo. H. Bliss & Co., general selling agents of the Western Electric Company. He was with that firm for three years, during which time he frequently devised various forms of electro-medical apparatus for the use of physicians. For five years he was in charge of the Northwestern business of the Brush Electric Company as electrician and salesman. For a time he acted as engineer of a company which handled his own electrical inventions for various purposes. Since that time he had been an independent engineer and expert. He stated that he now earned his living principally as an engineer designing new apparatus for those who wished it, in testing electrical devices, in original investigation, and in giving expert testimony. He is also qualified to earn his living as a mechanic.

In reply to a request about information as to the form of dynamo for the State, Mr. Brown stated that he had made a contract with Gen. Austin Lathrop, Superintendent of State Prisons, under which he purchased three dynamos, one each for Clinton, Auburn and Sing Sing prisons, of the alternating current type, each a 650 light machine made by the Westinghouse Electric Company, of Pittsburgh. They would each give from 1,000 to 1,500 or 2,000 volts pressure. After giving a technical description of these machines, he denied having recommended any way in which to apply the current to a criminal.

Reference having been made to the measuring apparatus connected with these dynamos, he explained that there had been a great deal of foolish newspaper talk about the varying resistance of the human body, and so, at the suggestion of General Lathrop, a Wheatstone bridge had been provided, by which it could be ascertained if any abnormal resistance existed in the subject and the electrical pressure increased to correspond. Owing to these newspaper dis-

cussions the State officials had decided to allow ample leeway, and provide a pressure equal to any emergency.

"That is to say," interjected Mr. Cockran, "that if you cannot kill a man at the first trial the force can be increased?"

"Not at all," replied Mr. Brown; "the emergencies I speak of are possible damages to wires through accidents or the slipping of a belt that would diminish the force. We can accurately determine the resistance of the criminal in advance by the use of the Wheatstone bridge, by introducing a feeble, imperceptible current."

"Do you mean to say this measurement is exact?"

"We can determine the resistance as readily as we can obtain a man's weight. We obtain, however, the maximum figure."

"Suppose death does not ensue, what would be the criminal's condition while the doctor was increasing the current?"

"The measurement made is always so high that death should ensue instantly."

"But have you ever had an opportunity to measure the resistance of a man who was actually killed by electricity?"

"No; the experiments have always been made on animals."

"What do you know about killing men by electricity?"

"I could give many instances where men have been killed by the Westinghouse dynamo with a maximum pressure of 1,000 volts. James Kearney, a fireman at Pueblo, Col., was killed in April while standing in a pool of water, by touching a wire having a 1,000 volt current. The resistance he offered with his non-conducting rubber boots must have been much greater than if he had a metallic plate at his feet and an electrode at some other part of his body."

"Did you see this death?"

"No, sir. All of the deaths so far by electricity have been accidental, but I could produce many witnesses."

Mr. Cockran was very determined in his attitude not to permit the witness to testify as to anything which he did not actually see or experience. He was exceedingly inquisitive as to the accuracy and veracity of the Wheatstone bridge, and how it was known to be accurate. The statement that it had been calibrated and compared with well-established standards was hardly sufficient to satisfy him.

The first day's sitting of the Referee was not largely attended, as its beginning had been kept rather quiet, and it had been announced to take place at 78 Broadway.

On Tuesday morning, however, Mr. Cockran's office was crowded with lawyers, experts and reporters, and the day's proceedings were exceedingly lively. Much disappointment was felt at the absense of Mr. Gerry, as there is a general desire to learn the exact facts as to how electricity came to be adopted as the best possible method of inflicting capital punishment. In the absence of Chairman Gerry, Harold P. Brown was again placed on the rack.

He said he did not hold any certificate of qualification as electrical engineer from any institution, but wasa self-made electrical expert. He had compiled a list of 91 people who had been killed by electricity, as he had learned from coroners, officials and other reliable sources. He knew nothing of the conditions under which they were killed, and had heard of many who had come in contact with dynamo currents who were not killed. He had himself taken a heavy charge from a dynamo, and had the flesh burned from his hand. He did not believe, however, that any person ever withstood the full pressure from an ordinary dynamo and survived.

The witness, then, under questions from Mr. Cockran, went over his experiments made upon living animals by which it had been determined that the alternating current was of a more deadly character than the continuous. He stated that he was not associated with Mr. Edison, but that he was on friendly terms with that gentleman and did not consider the current used in his system dangerous to life.

The connsel of the State then took Mr. Brown, and after hearing from him further details regarding the experiments spoken of, asked him the following question:

"As a result of your experiments, do you swear that, in your judgment, the instruments you furnished the State for the purpose will execute condemned men speedily and painlessly?"

"I do," he replied. He then repeated his assertion that the average resistance of the human body was 2,500 ohms, and that he would fix upon 4,000 ohms as the maximum of such resistance. The highest he had found in animals was 30,000 ohms.

On cross-examination by Mr. Cockran, the witness acknowledged that the real object of the pamphlet published by him was to show that high tension alternating currents were dangerous, and that high tension continuous currents could be made safe. In the preface he stated that by his safety device he could make it almost impossible to produce death with a continuous current not exceeding 3,000 volts. He knew of no experiments to test the action of the electric current on human beings previous to June 4, 1888, the date of the new law.

After a little discussion on static electricity, the dissection of the animals killed by electricity in the experiments last summer was then taken up. The object of this inquiry was to ascertain if sufficient time had been allowed to permit any of them to revive in case they had not been actually killed by the current. The body of the horse, it appears, was not removed until the following day, and this was also the case with some of the dogs. The calves, however, were given no chance whatever. They were immediately cut up by butchers, the inference being that they were converted into marketable veal.

In the re-direct examination by Mr. Poste, Mr. Brown stated that Ohm's law was universally recognized by electricians as absolutely correct, consequently the resistance of an object, and the E. M. F. being known, the strength of current could be ascertained. In his experiments on living animals this could be ascertained only approximately, owing to the varying resistance of the subject.

"Inquiry has been made about the burning effects produced by the application of the current. How may such effects be produced?"

"In case the hands grasped a conductor of small size, say an ordinary electric light wire, there would be parts of them which would have less area of contact than other points. This effect would confine the burning effect to those parts, which would continue until the moisture was thoroughly dried and the contact broken, or until the skin was carbonized."

"Is there any difficulty making an electrode which would give a good contact with a living body?"

"There is no difficulty."

"If such a contact is made with a properly devised electrode, is there any danger of burning if an abundance of moisture is present, or is there any difficulty in supplying the fluid?"

"There would be no burning and no difficulty in supplying the fluid."

"State your opinion, from your experience and knowledge, as to the intensity of the current necessary to kill a man if applied to the head."

"Beyond any doubt in my mind a pressure of 1,000 to 2,000 volts alternating current led into the body by suitable electrode, and through the body from head to foot, would be fatal."

"Take a man having a resistance of 50,000 ohms, would that vary your opinion?"

"It would not."

"With a current of from 1,000 to 2,000 volts?"

"If it were properly applied."

"In what time would death ensue?"

"Within 15 seconds."

Mr. Cockran then elicited from the witness the statement that he studied static electricity at school, and also his positive opinion that Ohm's law applied to the alternating as well as to the continuous current.

The hearing was then adjourned until Thursday at 10.30 o'clock.

On Thursday morning, Mr. Franklin L. Pope was put upon the stand. Mr. Pope said he had been an electrical engineer for eighteen years; for about a year he had been in the employ of the Westinghouse Electric Light Company; was a member of the American Institute of Electrical Engineers; he was its second president, and since his term of office had expired, he remained a member of the Executive Council. He did not know of any particular qualification necessary for membership in that body except a good knowledge of the applications of electricity. The Institute of Electrical Engineers is something analogous to the Institute of Civil Engineers; a man's membership has a distinct bearing on his professional standing, but not all practicing electrical engineers belonged to the body.

The examination then turned on the question of the accuracy of the Wheatstone bridge in determining resistances.

"Do you think, Mr. Pope, that the electrical resistance of a human being can be determined?"

"Not accurately; that is impossible."

Mr. Pope did not think that the Wheatstone bridge would indicate with any degree of certainty or uniformity the resistance of a living organism; what it was used for by electricians was to determine the resistance of metals and other materials. Mr. Pope said he had that very morning tested, for the first time in his life, the Wheatstone bridge for indicating the electrical resistance of the human body. The tests took place in the electrician's office of the Western Union Telegraph Company. He himself was the subject, and he was assisted by Mr. G. W. Gardinier, the electrician there. The results were that a 1 volt current showed a resistance of 6,300 ohms; 10 volts, 5,140 ohms; 50 volts, 3,850 ohms; 100 volts, 3,500 ohms. Thus the amount of resistance was never absolute, but varied in every case with the electromotive force used in the test. If the test had been made on metal, the result would have been uniform. There were no means known to science by which the resistance of a living organism could be accurately determined. Witness was familiar with the Westinghouse dynamo intended for commercial electric lighting. Its E. M. F. was 1,050 volts, and he did not think it could generate the force claimed for it by Mr. Brown. He heard Mr. Brown say that he had known of an electric spark having been projected thirty-six inches; he did not know that such a thing had been done; so far as his experience went the maximum distance was sixteen inches. The distance a spark of lightning is projected had never been accurately measured, although it was well known that it was much greater than the artificial spark. Mr. Pope differed from Mr. Brown, who testified that by keeping moist the electrodes used in electrical execution all burning of the flesh could be prevented. Some burning would occur if the current were powerful enough to cause death.

"Then what, Mr. Pope, in your opinion, would be the effect on the human body, of applying a current of 1,050 volts from a Westinghouse dynamo, such as Mr. Brown proposes for use on criminals?"

"It would certainly burn the flesh. How much I cannot say, for I do not know the exact effects of the moistening of the electrodes."

In reply to further questions from Mr. Quinby, Mr. Pope said that he had reason for believing that the death by electricity was an exceedingly painful one, and that so far as the practical bearing of the experiments on animals went, he regarded them of little value.

The hearing was adjourned to Monday morning at 10.30, when Mr. Matthew Hale will be present, and is expected to give some valuable and interesting evidence.

On Friday afternoon some tests with the Wheatstone bridge were made on human resistance at the Edison laboratory, but it does not appear that any new facts were developed.

Commissioner Gibbens was put on the stand on Monday morning to testify in the investigation in connection with the Kemmler case now being held at Mr. Cockran's office in the Equitable Building. Mr. Cockran put the question: "Now, Mr. Gibbens, what is the greatest electrical resistance you have any experience of?"

"The resistance of the companies to putting their wires underground," replied the ready commissioner, with an unmoved face and a merry twinkle of the eye.

Summer Diversions at Aurora, Ill.—A special dispatch from Aurora of July 8 says: "The first dog execution by electricity occurred at 6 o'clock to-night. The mayor, marshal, two reporters, superintendent of the electrical lines and an assistant were present. They had no arrangement for keeping the dog in the circuit and he was not knocked out till the third round." The arc light current is being used for the work.

Nickel in the Slot.—THE ELECTRICAL WORLD, of June 15, contained an article illustrating a "drop a penny in the slot" device used in the Egyptian temples before the Christian era, from which a certain amount of water could be obtained. During the past week numerous water coolers have been placed at prominent points about Chicago and in the large office buildings, and by dropping one cent in the slot a glassful of cold Waukesha mineral water can be obtained, a blessing to hundreds of men and women who do not care to drink carbonated beverages, or can ill afford the extra expense.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, July 15, 1889.

Mr. P. C. Ackerman came home a few days ago from a prolonged Western trip, and reports securing a number of large orders.

The Freeman Electric Manufacturing Company has been formed with a capital stock of $50,000 by W. P. Freeman, J. W. Robertson, W. H. Cotterell, R. W. Morgan and S. Blovelt.

Baseball.—The employés of The E. S. Greeley & Co. played a game of baseball on July 6 with a nine from the Empire City Electric Company, and won by 34 to 11. The match was played in Prospect Park, Brooklyn, and lasted two hours.

Mr. J. B. Crouse of the Standard Carbon Company, Cleveland, O., was in New York last week, and reported trade as excellent. The factory is now turning out one and a half million carbons a month, and the outlook for coming business is promising,

The Marr Construction Company, whose New York office at 171 Broadway is in charge of Mr. C. D. Doubleday, issue an imposing list of plants lately installed by them, including central stations all over the country, as well as in Cuba, South America etc. In Philadelphia they have a 10,000-light installation going into the public buildings on Broad street.

Wire for Theatres.—The new California Theatre, illustrated in the last issue of THE ELECTRICAL WORLD, is wired throughout with the Grimshaw wire of the New York Insulated Wire Company, for the Mather plant. This wire seems to enjoy special favor for theatre work, which is not by any means the least exacting of the kind. It is in use in this city alone at the Union Square, Proctor's, the Star, the Amberg and the new Harlem Opera House, representing a total of hundreds of thousands of feet.

The Mutual Electric Manufacturing Company, of Brooklyn, operating under the Knowles system, have issued a sumptuous illustrated pamphlet regarding their apparatus, methods, etc. It is a beautiful and most interesting production, and the apparatus it describes gives evidence of great ingenuity and electrical knowledge. The company are ready to negotiate with substantial parties for the introduction and development of their combined system of arc and storage battery incandescent lighting in different parts of the country.

The American Leather Link Belt Company, 72 Cliff street, report large sales to electrical companies of their well-known belts. Orders have recently been filled for the Thomson-Houston plant of the Bellville Electric Light Company, Ill., the Edison Company at Rochester, N. Y.; the Western Electric Company at Chicago; the City of Mexico Electric Light Company, the Sawyer Man factory in this city, and for the Westinghouse plant in the Grand Pacific Hotel at San Francisco. Recent orders are from the Kingston Electric Light Company, Can., and from the Stroudsburg Pa., Company.

The Empire China Works, of Green street, Greenpoint, Brooklyn, have issued a new price list of hard porcelain electrical supplies. It illustrates their various specialties and novelties, and gives information as to price, etc. The hard porcelain used by this concern is a very superior material, suitable equally for glazed and unglazed insulators. It is the porcelain allowing the body to be made of the same material as the glaze, and both to be made vitreous in the same heat. It is perfectly non-conductive throughout, and is remarkable for its strength and general applicability to electrical purposes.

Mr. Owen Walsh, 105 Walker street, is manufacturing alarm whistles, speaking tubes, etc., in large quantities, and gives special attention to this department of a large business. His products include, also, bell tubing, elbows, and a full line of electrical supplies, a large stock being carried at all times. Mr. Walsh occupies an extensive building, and the processes employed in the manufacture of his goods are not only numerous and ingenious, but involve the exercise of much care and experience. A high standard enables him to meet competition, no matter how severe it may happen to be.

E. S. Leaycraft & Son, electrical and pneumatic engineers, 14 Cortlandt street, are doing an excellent business in supplying pneumatic tube systems. One piece of work of this character is now being finished at Washington, D. C., where they are furnishing all the apparatus, including automatic machines. The electrical department, under the supervision of Mr. E. D. Leaycraft, has grown to good proportions, since its organization in April. The firm contract for all kind of work in their province, and give special attention to electric gas lighting, burglar alarms, call bells, annunciators, and other equipments of that kind.

Mr. E. A. Wildt, of 83 Murray street, having invited me to call upon him, I did so at my earliest convenience, when I was greatly surprised and pleased to see that he had at least trebled his facilities for manufacture, and had added power. Mr. Wildt had heretofore depended on foot power, but he now has a neat 4 h. p. Otto gas engine, a dozen more lathes, and mechanics enough to man them. He has just produced some fine oxidized silver letter boxes, set up in an elegant manner. He is also making one of the best door openers, and has a line of bells of superior make and finish. Annunciators and alarms are a hobby of his, and of household electrical supplies he has made a specialty for years.

Introducing Small Motors.—A conversation the other day with one of the officers of a leading motor company brought out the fact that in this city there are large numbers of manufacturers on a modest scale, who are very desirous of using electric motors for their business. They are unable, however, to employ the machine for their factories, from the fact that the present persistence of the Board of Electrical Control in refusing permits, prohibits connection being made between the motors and the circuits. The development of business is thus interfered with, and there is no doubt that injury is done to a great number of small industries.

The Magnolia Metal Company, 74 Cortlandt street, report an active demand for their metal in electrical work, and believe that its merits are being rapidly appreciated for use in electrical apparatus where high speed is often a matter of necessity, and where it is further imperative that the bearings shall remain as cool as possible. As an instance of ability to stand high speed, it may be mentioned that during some tests made at the Erie Basin Dry Dock, at 2,000 revolutions per minute and 471 pounds pressure per square inch, the Magnolia did not attain a temperature at any time of more than 128 degrees, while the average was much less, as compared with that of other metals, which reached nearly 500 degrees. Other tests made later brought out results equally satisfactory.

Woodbridge & Turner, the electrical engineers and contractors, 74 Cortlandt street, inform me that they have recently completed an electric road at Marlborough, Mass., on the Sprague system. The road has now been in successful operation since the

middle of June, and the last they saw of it when they left was that the motor car was hauling an extra car full of passengers. Two motor cars are now in use, and there is talk of putting on two more, as the traffic is growing at a very rapid rate. Woodbridge & Turner have secured the contract for the Troy & Lansingburg street railroad, which is also to be equipped on the Sprague system, and they will put on six motor cars. For the overhead system they will use the silicon bronze wire of the Aluminum Brass and Bronze Company, of Bridgeport, Mass.

Terra Cotta Conduits.—I understand that the Erie Telephone Company are considering the installation of terra cotta conduits at Cleveland, O. This idea is criticised here, and some little surprise is expressed that Mr. McKinstry, whose reputation as an electrician is high, should make such a selection. It is said that terra cotta cannot be laid and made air and water tight, but that on the contrary it easily allows the introduction of gas, etc., so that the conductors within are destroyed. Moreover, it is said by some that it is liable to damage in any case of street opening, either by the pick or by falling of its own weight. If systems of the pipe character are desired it would seem that there are other materials in the market well known, that have stood the test of years, that would answer better for the purpose.

The Straight Line Engine Company held their annual meeting on July 1. It appears that the company have recently purchased several acres of ground at Syracuse, N. Y., adjoining their present property, on which to erect new shops, giving them better facilities for meeting the demand that has arisen for their product. The officers for the year are Prof. J. E. Sweet, President; A. A. Sweet, Treasurer; and H. M. Williams, of Williams & Potter, Secretary. The company have increased their capital stock to $100,000, and now propose to get abreast of their orders. Mr. F. B. Hayward, mechanical engineer, of Williams & Potter, is meeting with a very encouraging reception abroad, and believes that the Straight Line engine is rapidly making a place for itself in Europe. He will undoubtedly bring home some good business for the firm, as the performance of the engine at the Paris Exposition has excited the attention of European engineers.

Messrs. Zimdars & Hunt, 234 Mercer street, New York, the old and popular pneumatic and electrical manufacturers, can safely claim that their goods are known the world over. It is only of late years, however, that they have added a full line of electrical supplies. They brought out lately a new annunciator and alarm drop of most ingenious mechanism. The great feature of this drop is that after the current has passed into the magnet of the drop, and the drop has fallen, the current is shunted out of the drop magnet and the full current passes entirely into the bell circuit, and the bell gets the full power of the current, which is most necessary. This avoids the use of extra batteries, as drops generally will continue to vibrate after falling, taking up the current that should be used on the bell. Their pneumatic annunciators and apparatus have also been vastly improved in latter years to compete with electricity, and they will be found in large numbers of elevators, homes, offices, etc., everywhere.

The Hill Clutch Works, through their Eastern manager, Walter C. Wonham, inform me that in addition to the recent shipments of power transmission machinery and "Hill' friction clutches to the Brush Electric Company, Buffalo, Salem Electric Light Company, Fitchburg Gas Company, and the city of Bangor Me., they have also made large shipments of their well-known specialties to the Belfast Electric Company, Belfast, Me.; Quincy Electric Light Company, Quincy, Mass.; Thomson-Houston Electric Company, for shipment to Bilboa, Spain; the Thomson-Houston Electric Light Company, Lyons, N. Y.; the State Hospital, Poughkeepsie, N. Y. American Tool and Machine Company, Boston; Edison Machine Works, New York; Jos. Bancroft & Sons, Wilmington, Del. They further inform me that trade continues good, and they are taxed to the utmost on orders from their regular customers, to say nothing of new business which is coming in to them astonishingly fast.

The Elektron Manufacturing Company.—Through the courtesy of Mr. E. H. Cutler, treasurer and manager of the Elektron Manufacturing Company, Jay and Plymouth streets, Brooklyn, I had the pleasure of going last week through their well equipped factory, where a large amount of work is in actual progress. The company have lately made great improvements in their armatures. Formerly the Siemens winding was brought straight over from end to end, with pins to divide the layers. Now toothed laminated sections are used, the teeth running diagonally from end to end of the armature. The electrical effect is good, and the pull obtained is continuous and remarkably strong. Being well equipped with beautiful machinery of all kinds, the company are enabled to produce their motor at greatly reduced cost, and to furnish a really superior machine. Last June they shipped over 150 motors of sizes ranging from ¼ to 2 h. p., and during the present month their orders have rapidly increased again. One feature of the business which interested me very much was the drying out of the armature by electric heat. The special drying chamber is heated by electricity, the current passing through high resistances; and the temperatures obtained are so high that one's hand can hardly be kept on the armature. The Ansonia Brass and Copper Company have been furnished with an 800 watt machine for testing purposes, and a 2 h. p. dynamo has been supplied to Milwaukee for storage lighting. These motors are now running at the Paris Exposition, doing work under the care of Mr. W. D. Sargent, president of the company, and the manager of the Bell telephone exhibit. Perret motors are also running Gold and Stock printers. in New York, as well as large numbers of fans, ventilators, dental lathes, gear-cutting machines, etc.

The Okonite Company.—A writer in a recent issue of the *New York World*, speaking of the large manufacturers located at Passaic, N. J., says of the Okonite Company, whose factory is located there: "The story of the growth of this concern resembles more a fairy tale than a statement of blunt business facts. Started four years ago it occupied a portion of the building (factory No. 2) of the New York Belting and Packing Company, but the rapidly increasing business of both concerns necessitated the building of large, new works for the latter, which are now in course of rapid construction. The first year's business of the Okonite Company amounted to about $9,000, while this year's business will reach the enormous sum of over $500,000. The word okonite is a name applied to a compound and process for insulating aerial, subterranean and submarine cables, also telegraph, telephone and electric light wires. This process is said to have surpassed all others in flexibility, indifference to heat and cold, and all other climatic changes. It is absolutely impervious to moisture. It has stood the most severe tests, and has received the highest recommendations from such practical and scientific experts as C. F. Goodrich, Commander U. S. N. and Inspector of Ordnance; Captain A. E. Black, commanding submarine defenses of the Clyde, Glasgow, Scotland; W. C. Temple, General Manager Metropolitan Electric Service Company; J. Hopkinson; H. H. Rebbech, Superintendent Fire Alarm, Cleveland, O.; R. E. Thompson, Acting Signal Officer at Washington, and one of the highest authorities on such matters in this country, George A. Hamilton, Western Union Telegraph Company, and many others." W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, July 15, 1889.

Mr. S. A. Barton, who has been in Boston for the past two months, returned to his home in Chicago last week.

Winthrop, Mass.—Great Head Hotel is being furnished with arc and incandescent lights by the North Shore Electric Light Company.

Booth Bay Harbor, Me.—The Marr Construction Company have just installed a 100-light direct current Westinghouse dynamo for isolated work, to be driven by a Westinghouse engine.

Bar Harbor, Me.—A new electric road is being proposed in Bar Harbor, to run over the route now occupied by a line of barges, passing through the property of the Mount Desert & Eastern Shore Company.

Cambridge, Mass.—The New England Telephone and Telegraph Company was granted a hearing by the Board of Aldermen, in the petition for permission to erect poles. Considerable opposition was met with, and the matter has not yet been decided.

Newport, R. I.—The Newport Improvement Society, organized among the cottagers, to oppose the electric railroad, and whose petition to the Supreme Court for an injunction restraining the running of cars was denied, is now petitioning the city council for the removal of the tracks.

The Thomson Electric Welding Company are now comfortably settled in new quarters on the fourth floor of the Fiske Building, 89 State street, where they have more room to grapple with their largely increasing business. They are still overcrowded with orders, but are now better able to handle them since the addition to their factory was completed.

The Municipal Signal System Company had a narrow escape last week from having their handsome offices on 79 Franklin street destroyed by fire. A fire broke out about 3 A. M. in the floor above them, occupied by the Pope Manufacturing Company, and the delicate mechanism of the instruments of the Municipal Signal Company was damaged by water to the extent of $1,500, which, however, was fortunately covered by insurance.

In Town.—Mr. Arthur D. Newton and Mr. M. E. Baird, of the Eddy Electric Manufacturing Company, were in the city this week on special business. Mr. F. W. Harrington, of the Western Electric Company, has been visiting his many friends in this city this week. Mr. Frank G. Stone has favored Boston with a flying visit this week. Mr. C. D. Smith, agent for the National Carbon Company, of Cleveland, O., was a caller at this office during the week.

Beverly, Mass.—The selectmen have given a hearing to the Robinson-Foster Electric Motor Company, who have applied for the right to establish a plant to furnish power to the city for manufacturing purposes. Considerable opposition was met with from the Beverly Electric Light Company, who stated that they would furnish power within ten days if they were guaranteed five horse-power. The selectmen have taken the matter under consideration.

The Standard Electric Company, Hartford, Conn., has now been organized under the laws of the State of West Virginia, with Mr. L. M. Thompson as President and General Manager. Besides a number of electric specialties, this company controls the "Standard" primary battery for Connecticut, and is now ready to furnish light and power on that system. Mr. Thompson expects to get a contract to light the State encampment at Niantic in August.

The Bernstein Electric Company are pleased with the arrangement they succeeded in making recently for the establishment of a Western Agency, in Chicago, for their well-known specialties in series incandescent lighting. Their agent is Mr. George Cutter, of 80 Adams street, that city, who no doubt will soon be able to report the general introduction of the Bernstein Company's lamps, sockets, etc., throughout the great West. A complete line is to be carried in the Western office.

Off for St. John.—An excursion boat will be placed on the line of the International Steamship Company, leaving Commercial Wharf, this city, for St. John, N. B., direct, on Saturday evening, July 20, at 6 P. M., arriving at St. John Sunday afternoon. The Electrical Exhibition opens on July 22, and it is expected that many Americans, electrical and otherwise, will avail themselves of this chance. Excursion rates will prevail, and return tickets will be good on other boats up to a limited time.

West End Street Railroad Company.—Horse-cars on the Cambridge and Arlington lines will be discontinued at once, so that the electric cars may have an opportunity of running up to their full speed, which they cannot at present do. Regular stopping places will be established, about a quarter mile apart, along the route. The time-table shows a saving of thirty minutes on a round trip between Arlington and Boston. Every motor car will draw another car, to provide better accomodation. The action of the aldermen in granting permission to the West End Street Railroad Company to use overhead lines and poles has just been approved by the Railroad Commissioners.

The Worcester Polytechnic Institute, at Worcester, Mass., so widely and favorably known as a school of mechanical engineering, has, during the past year, built and equipped a new laboratory—the gift of the Hon. Stephen Salisbury—which cost over $100,000, and is to be devoted largely to chemical and electrical work. The electrical equipment is very complete, embracing a large assortment of standard test instruments imported especially for the school; direct and alternating dynamos and motors, arc and incandescent lamps, direct reading dynamometers, engines, boilers, etc., etc. A regular course in electrical engineering will begin with the fall term of the present year.

Novel Application of a Phonograph.—Messrs. Nicholls & Co., stockbookers at 26 Congress street, Boston, have recently adopted an Edison phonograph to assist them in their quotations of California mining stocks, for the purpose of providing a varying market for their customers. Mr. G. W. Rumble, the owner of the mines, and originator of the idea of using a phonograph, is always on hand to explain his method. Every evening Mr. Rumble speaks into the phonograph about 500 different quotations, using about twenty cylinders, and occupying nearly two hours. During the day these quotations are called off by the phonograph, and distinctly heard all over the room. A boy notes down the varying market on the board in the usual manner, while Mr. Rumble controls the action of the phonograph, so as to prevent the quotations being called off too fast.

Electric Gas-Lighting Company.—As a specimen of the excellent workmanship which this company is capable of turning out, the automatic sectional cut-out, for the protection of gas-lighting circuits, which they have recently completed for a special order from Onla D. Allen, Detroit, Mich., may be cited. It is looked upon as a masterpiece. It has been specially designed for a lady who is the owner of one of the finest mansions in Michigan, is double the ordinary size, and is a piece of apparatus which no one would be ashamed to see even in their drawing-room. The metal parts are silver-plated, with platinum points, and are contained in a polished case of antique oak, with a thick glass front with beveled edges. It is not too much to say that it is the finest apparatus of the kind ever made in this country, and the Electric Gas-Lighting Company have reason to be proud of their workmanship.

Non-Electric Telephones.—At present there appears to be quite a large demand for a cheap telephone which can be bought outright and which can be utilized with success over comparatively short lines. It is an undoubted fact that such a telephone can be procured, and will prove of very valuable service to any one requiring connections between two houses. There is, however, a limit to the utility of these instruments; and as a matter of protection to readers, I would point out the fact that it is not possible for an acoustic or non-electric telephone to give satisfactory results over a line of great length. As to the possibility of establishing central stations or exchanges in the small towns and cities, it is argued by many that the very principle of the instrument precludes it from ever being used, as the connections in such an exchange between any two subscribers would always require to be in rigid tension. It is possible, however, for one house to be in connection with several others, so that each house could communicate with the first though not with one another. Such a plan has just been accomplished by the National Telephone Manufacturing Company, at Marblehead, where the stables of the Crowninshield Hotel are connected with seven cottages owned by the proprietor of the hotel. This company is also connecting six different houses for the Boston Manufacturing Company, of Waltham, and the various hospitals in Boston are all using the Bennett telephone. This telephone is enjoying a well-merited success, and among the different companies who have recently adopted it may be mentioned the following: George H. Thurston & Co., Providence; W. H. O'Beirne, New Orleans; Mount Vernon Electric Light Company, Mount Vernon, O.; Brownwell & Green, 927 Broadway, New York; Charles L. Gately, 160 Broadway, New York; L. W. Wolfe & Co., Omaha, Neb., and many others.

A. C. S.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
39 Mallers Building, Chicago, July 13, 1889.

Edward Lasalle, Kansas City, called on his friends en route home from a vacation in New England.

The Windsor Theatre, Chicago, will be lighted with electricity, but no system has yet been secured.

Lieut. A. M. Thackara, Philadelphia, was entertained by Mr. E. Baggot at the Electric Club rooms on last Tuesday.

F. M. Shaw, land agent Missouri Pacific Railway, has been visiting Chicago in the interest of a town lighting company.

The Faraday Carbon Company, of Pittsburgh, are now represented in Chicago by Mr. C. B. Curtis, at 175 Randolph street.

Mr. Charles Cone will make a special business trip through the Eastern States in the interests of the Electrical Supply Company.

The Elmer A. Sperry Company have leased factory room in the unburned portion of the Burton block, and will there continue business.

W. G. Halm, vice-president of the Perkins Electric Lamp Company, has returned to Chicago from a successful business trip through the west.

L. W. Toles, manager of the electric light plant at Charlotte, Mich., has been in Chicago looking up the matter of installing an alternating system.

The Pittsburgh Police say: "The city arc lights are doing more to prevent crimes of various kinds than a double force of policemen could do."

The Central Electric Company, Chicago, are sending out handsome sample cards of silk and cotton-covered conductor cords for incandescent lamp circuits.

E. T. Sykes & Company, of Minneapolis, secured the contract for furnishing an electric light plant to the city of Anoka, Minn., for about the sum of $5,312.

Mr. W. J. Clark will be in charge of the Western office of the Thomson-Houston Railway Department in Chicago during the absence of Mr. Theodore P. Bailey in the East.

Chicago Capitalists built the Texas State House, and now the Chicago office of the Thomson-Houston Electric Company have sold a 600-light incandescent plant to be installed therein.

C. H. Reynolds, general superintendent of the Omaha & Council Bluffs Railway & Bridge Company, has been in Chicago during the week in consultation with the Thomson-Houston Electric Company.

City Electrician John P. Barrett states that of the $300,000 appropriation for city electric lighting, he will apply about $275,000 this year to extension of the plant, starting about next Christmas.

The St. Paul Gas Light Company are so well satisfied with the results obtained by S. S. Leonard in burning fuel oil that they will experiment with the same in the furnaces of their electric light plant.

W. C. Stewart has assumed the duties of local manager of the Missouri & Kansas Telephone Exchange at St. Joseph, Mo., relieving W. M. Yenawine, who has been appointed assistant manager of the company.

The Central Illuminating Power Company, Chicago, has been incorporated to furnish light, heat and motive power; capital stock, $50,000; incorporators, M. B. Austin, Fred B. Uhrig, M. B. Cannon.

The California Electric Light Company will erect, in Chinatown, San Francisco, six Brush arc lights on 40-foot masts to aid the police in detecting crime and arresting offenders in the Chinese quarters.

The Baraga Graphite Mine, recently discovered three miles from Taylor's Junction, on the Duluth & South Shore line in Michigan, promises to be a matter of more than ordinary importance to users of pure carbon.

Mr. H. A. Kinney has sold to his partner, A. H. Zenner, his interest in the Nebraska Electric Company, and goes to Colorado for better health and to look after the interests of the Pumpelly storage batteries in the West.

The Saginaw, Mich., Union Street Railway Company are endeavoring to secure a franchise to put in electric motive power. Detroit parties are said to be negotiating for the line in the event of the franchise being secured.

The Western Electric Company, Chicago, have issued a large general catalogue that is a handsome addition to trade literature, the copy received being printed on heavy calendered paper and containing cuts of their new apparatus.

The Thomson-Houston Electric Compaany's Office have sold plants during the week as follows: To the village of Hyde Park, Ill., 100 incandescent lights; city of Visalia, Cal., 100 incandescent lights; Heilman & Son, Indianapolis, 50 incandescent lights.

The Metropolis Electric Light Company, recently formed at Metropolis, Ill., are in the market for an electric light system, and would like to have some capitalist become interested in same. William O. Towle and William R. Brown are two of the incorporators.

The Electrical Supply Company have recently had their P. & B. insulated wire tested by first twisting in sharp coils and then placing it for forty hours in solutions of caustic potash, sulphuric acid, nitric acid, etc., in each case the insulation resistance being over a megohm.

Club Visitors.—The following members and gentlemen from out of town dropped into the club during the week: William A. Kimball, Albany, N. Y.; Edward Lasalle, Kansas City; J. L. Baker, New York; Charles Cone, Kansas City; C. H. Reynolds, Council Bluffs; C. C. Warren, San Francisco.

The Minnesota Brush Electric Company, Minneapolis. are pushing the construction of the new power house along as rapidly as possible, and will soon have the 1,000 horse-power triple expansion Reynolds-Corliss engine, made by E. P. Allis & Co., in place. The 68-inch Munson belting is intended for this machine.

Mr. S. S. Leonard, General Manager of the Minnesota Brush Electric Company, Minneapolis, was so unfortunate as to step on a rusty nail a few days since and is now confined to his room. The sympathy of all the electrical fraternity will be extended to Mr. Leonard, whose able papers on the fuel oil question won a host of adm rers.

The Denver Consolidated Electric Light Company, by virtue of an ordinance passed July 6, succeeds to certain rights heretofore held by the Denver Light and Heat Company and the Colorado Electric Light Company. The plant to be operated is one of the finest in the West, including several hundred Brush arcs and a large number of incandescents.

The Chas. Munson Belting Company, Chicago, shipped their 64-inch heavy double belt, 131 feet in length, to the Louisiana Electric Light and Power Company, New Orleans, this week. The president of a bank who has taken special interest in the manufacture of belting, after a visit to their factory this week, stated that he had never seen as handsome belting as was shown to him by Mr. Thomas.

The Underwood Manufacturing Company, through their Chicago Agent, F. P. Mack, have placed one of their cotton leather belts 12 inches wide by 40 feet long on the dynamo in the Chicago Eden Musee; a twelve-inch belt 58 feet long in the electric plant at Swift & Co.'s packing house, Chicago stock yards, and belts on the dynamos on the steamers "John A. Dix," "Gordon" and the new "City of Racine."

Telephone Quotations.—Col. S. G. Lynch, broker, 146 La Salle street, Chicago, furnishes quotations upon telephone stocks as follows:

Chicago	$310@$325	Cumberland	$69@ $70
Central Union	60@ 61	Wisconsin	117@ 118
Michigan	84@ 85	Bell of Missouri	151@ 153
Great Southern	31@ 33	Iowa Union	23@ 25
Colorado	38@ 40	Missouri and Kansas	63@ 65
Rocky Mountain Bell	41@ 42		

The Brush Electric Company, Cleveland, Ohio, will, it is stated, bring suit in the September term of the United States Court against the Electrical Accumulator Company of New York and other concerns manufacturing storage batteries. The opinion of Justice Cox on the subject, affirming Mr. Brush's priority, will be found in full in THE ELECTRICAL WORLD, No. 13 of Volume XIII., also other interesting matter pertaining thereto.

Captain W. Thornton, of Philadelphia, is piloting a special committee of the city council through various cities in search of information on the underground question. The party are travelling in two Pullman coaches, have a number of ladies with them, and, strange to say, are paying their own expenses. They were shown around Pittsburgh on Sunday and Monday, and will visit Indianapolis, St. Louis, Chicago, Cleveland and Buffalo.

Milton Thomas, the Chicago agent of the New York Safety Engine, has sold the following engines, to be used in operating electric light plants: 70 h. p. to the town of Blue Island for the Excelsior plant; 30 h. p. for the Thomson-Houston plant at Huston's Pavilion, Chicago; 35 h. p. for the Edison plant in the office of the Milwaukee *Sentinel;* 100 h. p. to the Columbus, O., Electric Light and Power Company, being the thirteenth order, and one 12 h. p., three 8 h. p. and one 5 h. p. engines.

Chattanooga, Tenn., is the subject of an appreciative article in the Cincinnati *Post*. Among the leading industries mentioned is that of the D. M. Steward Manufacturing company, the well-known makers of the Steward patent lava electric insulators. This establishment is the only one of its kind in the country or in the world, and the insulators are in most extensive use. They are now being used, it may be noted, on the Chattanooga Electric Railway, where they are giving great satisfaction.

The Chicago Telephone Company had their income slightly reduced by the recent annexation, through the city council passing an order for an ordinance abolishing all tolls for telephone service within that district. The participants in the late rabid attack on the telephone rates appear to have regained their senses, and learned that a perfect exchange system can only be operated in a large city through the expenditure of sums of money that in in the aggregate amount to an enormous sum.

The Rich Hill Electric Railway Company, Rich Hill, Mo., incorporated under the Missouri State law, have secured a valuable franchise and contract from the city for twenty years, for an electric street railway and light and power plant. The officers of the company are W. K. Royce, President; Theo. S. Case, Vice-President, and R. C. Massie, Secretary, who have purchased the electric light plant of forty Sperry arc lights now in operation, and will rapidly extend same. No system for the railway has yet been adopted. The distance is about five miles and the grade light. Rich Hill is a promising city, having a population of some 6,000.

Prof. J. P. Barrett, Chicago's city electrician, has selected the four locations for the new electric light plants. The lots at the corner of Rice and Lincoln streets and at Aberdeen and Congress streets will have to be purchased from the owners, the other two locations being on city property near the corner of Sedgwick street and Chicago avenue and near the Exposition building. The plans for the power stations have all been drawn and the contracts let or bids received for the majority of the supplies, but no action has yet been t ken on the electric system to be used, and probably will not be before the end of September.

The Thomson-Houston Electric Company have purchased all the machinery, merchandise, patents, etc., pertaining to, or controlled, by, the Van Depoele Electrical Manufacturing Company, Chicago, and will transfer the same to their factory at Lynn, Mass., or make such other disposition as may seem best. The Van Depoel Company will continue to transact their business for the present, will fill all orders received, carry out all contracts made and settle all accounts. This absorption by the Thomson-Houston Company has been expected for some time, but no definite action was taken until the 10th inst., other reports to the contrary notwithstanding. The Van Depoele Company have done quite an extensive business in arc lighting in the past, and lately have secured several contracts for the Mayo system of incandescent lighting. But the greatest good accomplished was in promoting the introduction of electric railways. As in many other cases they did not reap the full benefit of the good seed they had sown, but much praise is due for pioneer work in that direction under the most disheartening circumstances. Geo. A. Mayo still retains full control of his incandescent system of electric lighting, and will start in business at Rockford, Ill., on Aug. 1.

Cincinnati Waking Up.—Cincinnati is not going to be behind her sister cities. She has just completed 35 miles of granite and asphaltum streets, the best in the country; has two cable street railroads, each over six miles long, and the Sprague Electric Railway Company has just completed the Mount Auburn electric railway, over four miles long, double track, running from the heart of the city to the Zoo Gardens. It is the admiration of the thousands who are using it daily. A more complete and satisfactory plant has not been installed anywhere. Two other electric roads are in process of building, and the days of horse cars are numbered in this city. Alderman Cherry, well known to the electrical people as president of the Standard Electrical Works of that city, is determined that his good old town shall not be behind, and has started a movement among the powers that be that will result in the streets of that city being properly illuminated by electric lights and its beautiful suburbs by incandescent lights. With these things accomplished, as they certainly will be soon, and natural gas to take the place of coal for heating and manufacturing, Cincinnati seems soon to be the queen city of the West in reality as she long has been in name.

Club Notes.—A few of the members of the Chicago Electric Club tendered a dinner on Wednesday evening to their worthy president, Mr. S. A. Barton, on his return from a six weeks' business trip in the East. Sixteen plates were laid. The participants joined in welcoming Mr. Barton home, and all had a most enjoyable time, as they naturally would, with Fred Degenhardt as toast master. The participants were: S. A. Barton, A. K. Stiles, B. E. Sunny, Fred Degenhardt, F. S. Terry, W. A. Kreidler, George A. Mayo, W. J. Buckley, Theodore P. Bailey, C. H. Reynolds, Omaha; C. H. Cone, Kansas City; Frank Butterworth, Edward Floyd, W. J. Clark, A. C. Durborow, Jr., Fred De Land. In a happy speech President Barton referred to the handsome quarters now occupied, to the increased membership, the probability of requiring additional rooms within a year, to the numerous little luncheon or dinner parties daily occupying the small rooms, and to the welcome visits of the fair sex who find it convenient to lunch in such cosey rooms. Mr. Barton also paid a compliment to the ex-president, A. K. Stiles, who was the first presiding officer of the club, and to whose suggestion is due the credit of the name and formation of the club. Mr. W. A. Kreidler also remarked that the first suggestion regarding the formation of the National Electric Light Association came from Gen. A. K. Stiles. General Stiles, in responding, referred to what had been accomplished by the club, and then spoke of several new applications of electric motor power that would shortly be heard of, one of which, a magneto mining machine, had already accomplished far more than was expected by its inventors. Among others Mr. C. H. Reynolds spoke of the electrical possibilities of the mid-west, and especially of Omaha, and doubted whether eastern people fully realized the opportunities there presented. It was one of the best speeches of the evening. Letters of regret were read from absent members who would gladly have been present, and at midnight the parting song was sung. F. DE L.

THE TELEPHONE.

The United States Rolling Stock Company has ordered 50 sets of the new Shaver accoustic telephone for use in its factories west and south. The company has had the apparatus under trial, and gives good proof of its satisfaction in this large order. The Shaver corporation are also preparing to fill some orders for central station apparatus.

The Government Telephone Suit.—The American Bell Telephone Company, in the suit now before the United States Circuit Court, in Boston, has asked to be allowed to withdraw its answer, and to file a plea in its place. The company has been seeking to limit the testimony taking to the question of fraud, as every other point was settled long ago, and this filing a plea would, it is said, accomplish the purpose.

THE ELECTRIC LIGHT.

New York City.—The various local companies appeared before Corporation Counsel Clark last week to argue on the protests they have presented against each other in regard to the awarding of contracts for city lighting.

Edison Patents in Canada.—A special dispatch from Ottawa, of July 10, says: "The Canadian Commissioner of Patents recently canceled the patent granted Edison for incandescent electric lighting in Canada, on the ground that the article in question was not manufactured in the Dominion within two years after the issue of the patent." Mr. Edison now gives notice of appeal. His plea is that the Commissioner had no authority to hear the application.

Jersey City, N. J.—The Hill Clutch Works, of Cleveland, O. with Eastern office at 18 Cortlandt street, New York, have just closed a large contract with the Jersey City Electric Light Company for the complete equipment of their new station with everything in the line of power transmission machinery and the "Hill" friction clutch pulleys and couplings. The plant will start with about 800 h. p. We congratulate them, as it certainly is a contract well worth having. The electric light company have shown good judgment in awarding it to them, as the Hill work is always of the highest grade. An examination of the machinery which they have recently installed in the Mt. Morris Electric Light Company's station, corner of Greenwich and Vandam streets, New York City, will show some very fine and substantial workmanship.

PERSONALS.

Mr. Henry L. Storke, the treasurer of the National Telephone Exchange Association, has recovered, we are glad to say, from his recent serious illness.

Mr. J. Potter, treasurer of the Brush Electric Company, of Cleveland, is in New York. During the absence of Mr. S. M. Hamill, Jr., the Assistant Secretary, who is enjoying a brief vacation, Mr. Potter will have charge of the company's Eastern office at 36 Union Square.

Mr. T. O'Reilly, well known as a leading spirit among telegraphers, and an intimate friend of Mr. Powderly, has been made editor of the *Journal of United Labor*.

Mr. W. M. Yenawine has been appointed assistant superintendent of the Missouri and Kansas Telephone Company, of Kansas City.

Mr. F. A. Laughton, of Bangor, Me., has asked the railroad commissioners for a charter for an electric railroad from the village in Bar Harbor to the foot of Green Mountain, to connect with the mountain railway.

J. Campbell Scott, manager of the Kentucky Phonograph Company, reports business rushing, but says there is a chance for some "Edison" to show his skill and make a fortune at the same time by improving the present motive power, as the primary battery now used he regards as a source of great trouble.

Mr. Maurice B. Flynn, the well-known New York financier and politician, died last week. He will be remembered by electricians for his close connection with New York subway matters and for his electric railway enterprise at Richmond, Va., of which, by the way, an interesting account by Ernest Ingersoll appeared in the *Commercial Advertiser* on July 13.

Mr. H. Ward Leonard has arrived in New York, and has made his headquarters at the Edison United Manufacturing Company's offices at 65 Fifth avenue, where he is in full charge, having immediately assumed his new and onerous respon ibilities. Mr. Leonard is a most welcome addition to electrical circles in New York. It is understood that as soon as the step can conveniently be taken, all the Edison departments in this city will be brought together under the one roof down town.

Mr. E. H. Johnson gave a most enjoyable lawn party at his handsome country residence, "Alta Crest," Greenwich, Conn., last Saturday afternoon and evening. The occasion was the fifteenth anniversary of the birthday of his eldest daughter. About 150 guests were present, including several well known in the electrical field. The house and grounds were brilliantly illuminated by electric lights and Chinese lanterns, and on top of the flag pole was an ingeniously arranged electrical pin-wheel, composed of red, white and blue electric lamps rotated by an electric motor.

Captain Willard L. Candee, treasurer of the Okonite Company, of New York, returned from his European trip on the 4th instant, as noted last week. He succeeded, besides taking several smaller orders, in making a contract with the city of Paris for 8,000 feet of Okonite telephone and telegraph wire. Captain Candee examined many important locations in England, with a view of establishing a manufactory there to supply the steadily increasing European demand for Okonite wires and cables. The captain gives a glowing account of the American department of the Paris Exposition, and says that the electrical manufacturers are not one whit behind those in the other great industries, notwithstanding that as yet the manufacture of electrical goods is only in its infancy.

Prof. T. C. Mendenhall, of the Rose Polytechnic Institute, Terre Haute, Ind., has been appointed by President Harrison as Superintendent of the Coast and Geodetic Survey. Professor Mendenhall was born near Hanoverton, Ohio, in 1841. He was professor of physics and mechanics in Ohio University from 1873 to 1878, and then went to Japan as professor of physics in the Imperial University in Tokio. During his stay he organized the general meteorological system of the Imperial Government. In 1881 he returned to the United States and resumed the chair at the Ohio State University. In 1882 he organized the Ohio State Weather Bureau service and subsequently devised a system of weather signals for display on railway trains. He became a professor in the United States Signal Service in 1884, and established stations in the United States for the systematic observation of earthquake phenomena. He resigned from the government service in 1886 to accept the presidency of the Rose Polytechnic Institute, Terre Haute, Ind., which position he still holds. Besides membership in other scientific societies, Professor Mendenhall has held the offices of vice-president of the physical section of the American Association for the Advancement of Science, and president of the National Academy of Sciences. He is the author of "The Century of Electricity," and has had charge of the electrical portions of the *Century* Dictionary.

MISCELLANEOUS NOTES.

St. Joseph, Mo., is to have a National Railway, Electrical and Industrial Exposition, beginning September 3.

The St. John, N. B., Electrical Exhibition.—The International Steamship Company have made a special excursion rate from Boston and back for the summer carnival and electrical exhibition at St. John, N. B. The round trip will cost only $5. The boat leaves the Commercial wharf, Boston, on July 20, at 6 P. M., and the ticket is good for the return trip until July 29. There is every prospect of a large attendance at the exhibition, and the opportunity is an excellent one for inviting and securing new trade.

BUSINESS NOTICES.

Battery Cut-Out.—Attention is called to a simple device for disconnecting gas-lighting batteries if accidentally grounded. It is cheap, sensitive, never needs watching, and has no clockwork to be kept wound. Terms furnished by the Electric Supply Company, of Syracuse, N. Y., No. 105 South Warren street.

The Brown & Sharpe Manufacturing Company, of Providence, R. I., are putting out an improved form of their well-known centre gauge and gauge for grinding and setting screw tools. It is one of those useful appliances that should be found in every workshop, where it can be made to give a great variety of service.

The Roaring Fork Electric Light and Power Company of Aspen, Colo., say that Schieren's Perforated Electric Belts are giving them the *best* of satisfaction; they claim, that these belts run smoother, straighter, and with less slipping than any other belts which they have used. Chas. A. Schieren & Co., (manufacturers) New York, Boston, Philadelphia, Chicago.

Patterson, Gottfried & Hunter, 146-150 Centre street, 111-115 Walker street, carry a complete stock of brass and iron machine and wood screws, cap and set screws, all kinds of bolts, taps, files, twist drills, brass and rubber tubing, brush copper, rod and sheet copper, brass rods, sheet German silver, sheet brass, machinery, tools, hardware, etc. Electric motor supplies.

The Friction Pulley Company, of Sandy Hill, N. Y, issue a neat little vest-pocket pamphlet, illustrated, in regard to their improved friction clutches, and their general line of shafting, hangers, couplings, plain and split pulleys. The clutch made by this concern has no end thrust, and may be started or disconnected at any rate of speed without stopping motive power, with perfect ease and safety. Very strong claims are made for the superiority of the apparatus, and a long list is given of well-pleased users of it.

Owing to the pressure on our columns, the Patent Record has been omitted this week.